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### PRESIDENTIAL ADDRESS\*

#### THE INFLUENCE OF THE FRENCH SCHOOL IN THE SIXTEENTH, SEVENTEENTH, AND EIGHTEENTH CENTURIES UPON THE DEVELOPMENT OF GYNECOLOGY AND OBSTETRICS

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WE gynecologists and obstetricians today owe a great debt to our professional forefathers. The distinguished men who created this Society and who have maintained its reputation have set us an example which it is not easy to follow. They have done a great work in the development of gynecology and obstetrics in this country and Canada. Before their day, however, there were able workers who searched for facts and who strove to develop better methods of dealing with the ills of women. In the hurry of daily work and with the rapid development of knowledge we find it difficult to keep pace with what goes on today and the work of those who have gone before us is easily forgotten. In order that we may take a brief view of the work of a group who have contributed greatly to our science I ask you to come with me for a short time while we mount an imaginary hill from whence we may look backward over a part of the road our predecessors have traveled and to view, if we may, some of the work of the laborers who have built the foundations upon which rest the scientific structure within which we work. This scholastic edifice is not yet complete. So long as men of

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scientific curiosity continue to be born and to strive to answer the questions which will occur to their inquiring minds, it will continue to grow. A pinnacle will be added here, a turret there, until it approaches that state of complete knowledge from which we are still far away.

But little real advance occurred in medical science for centuries, and it was not until about four hundred years ago that substantial additions began to be made to the sum of available knowledge in the field of obstetrics and gynecology. For many years we looked to the Germans for scientific knowledge but a tremendous amount of valuable work was done by the French school in the sixteenth, seventeenth, and eighteenth centuries, and it is with some of these obstetric and gynecologic pioneers that I purpose now to deal.

The first man who stands out as a real contributor to the progress of obstetrics was Ambroise Paré. He was interesting not only as a contributor to general surgery, and to our own domain as well, but as a man. He was born, in all probability, as there is some little discussion about the date, in 1509, in the village of Bourg Hersent. His various biographers have debated as to the actual date of his birth but Le Paulmier, who has provided one of the best accounts of his life, has gone to some trouble to fix the date and believes that 1509 is the most probable one. His father was a chest maker, *coffretier* being the word used to describe his trade. No great amount of information is available as to his early years, but it is known that he had no knowledge of Latin and Greek. The lack of acquaintance with these languages was a great handicap to him for some of his contemporaries argued that, being ignorant of these, he could not study the old authorities and therefore could lay no claim to a knowledge of surgery. He himself made no secret of his lack of early education, nor did he permit it to keep him from accomplishing what he set out to do. From what may be found concerning his physical characteristics it seems that he was a man of middle stature, active, able to endure great exertion and fatigue, and seemingly spared from illness throughout his life. The only disability we find in his career is a fracture of both bones of the leg sustained by the kick of a horse which he was urging upon a ferry boat. The fracture was compounded as he stepped back to escape a possible second kick. This healed after a number of months of inactivity. He was bitten by a viper while watching the compounding of a remedy of which vipers formed a part but treated himself and recovered. An apparent attempt to poison him was made but he recognized the presence of the poison in time to cease swallowing the food in which it was before too much had been taken. He was somewhat quick of temper, a fault which he shares with many men of energy and nervous force. He seemed to like good living and was not at all averse to a glass of good wine, but there appears nowhere any record which would make it appear that he was a heavy drinker. He had a ready wit, which could



be trenchant at times. For example, when speaking of powdered mummy, which was a highly esteemed remedy in France in his time, he said that he believed mummies made in France would be as good as those which came from Egypt inasmuch as both were quite useless.

His independence of mind may also be illustrated by his attitude toward the use of the horn of the unicorn as a remedy. This was supposed to be an antidote to all poisons. He did not believe this and doubted even the existence of such an animal, for, he said, of all the men who had traveled in all parts of the known world there was not one who had even seen it. Moreover, the written descriptions varied widely from one another. His own experience showed him that it was without effect, and, in spite of the great value generally accorded it, he discarded it as a remedy.

He began his professional experience with three years' service in the Hôtel Dieu in Paris, a service of which he spoke with pride in after years.

He accumulated a large estate, a feat which not all of his followers have been able to equal, and, like many others who have achieved material success, had relatives whom he must help and some of whom lived in one or another of several houses which he owned in Paris. Much argument has appeared in the writings of those who have dealt with his career as to his religion. It seems to be without doubt that he was a very definitely religious and God-fearing man, but whether Catholic or Protestant, has been argued by a number of writers. The weight of evidence seems to be that he was a Catholic, but he does not seem to have made any public show of his belief. He was married in the church of his parish and his children were buried there.

That he was a man of wide knowledge and quite able to form opinions outside of his own domain seems to be evidenced by the answer of the Duke of Savoy to the French king who wished to send Paré across the lines between their two armies to attend a high officer who was wounded and a prisoner. The Duke refused, saying, "He knows other things than surgery," evidently fearing that entirely too accurate a description of the enemy military dispositions might be carried back to the French army.

His time was divided between service in the armies and practice in Paris, the disturbed state of the times in which he lived providing him with a large amount of military duty. He evidently went upon his first campaign at the age of twenty-seven because of a lack of money, a condition which still sometimes affects the young physician. He passed the examination for barber-surgeon in 1541, and in 1554, that for master surgeon. He apparently had to take the latter twice, but the reason for this is not known. He learned at least a modest amount of Latin before appearing for the Master's examination. His lack of classical learning did not depress him for, said he, Aesculapius wrote in his language and he, Paré, had the same privilege. It was in 1537, his first

campaign, that he renounced the use of boiling oil and hot irons for the control of hemorrhage after amputations and from severe wounds. This was because the supply of hot oil failed and he had to have recourse to an emollient application made of egg yolks, oil of roses, and turpentine in its place. The improvement in results he instantly recognized and thereafter, against much opposition from his more statically minded confreres, refused to use them. In 1552, during the siege of Damvilliers, he amputated the leg of a gentleman in the suite of de Rohan, controlling bleeding by ligatures. The ligature had lain dormant since the time of Celsus, who described it in his seventh book. This controversy about boiling oil and the cautery produced for us a remarkable demonstration of his ability as a controversial writer for he was attacked



Fig. 1.—Ambroise Paré. Le Paulmier.

by Etienne Gourmelen who criticized severely his departure from the accepted methods. His reply, entitled an "Apology and Treatise," was not only an account of his travels and the surgical work which he found to do while accomplishing them, but was also a most biting and complete rebuttal, replete with sarcasm, calling attention to his own great practical experience compared with the largely academic knowledge of his opponent. Throughout this work he refers to his critic as "Mon petit maistre" which may be rather freely translated as "my little man." It is due to this attack upon Paré, and to his reply, that we know anything of Gourmelen. He was caught as a fly in liquid amber, and so preserved has come down to us. It was in this book that Paré

said "the operations of surgery are learned by the eye and by the touch." This polemic went on for some time for in 1593 Jean Des Hayes wrote a Latin thesis entitled "An Sistendo Sanguinem Ignis Vel Ligatura?" It was in his first campaign that we first find the expression so often quoted "I dressed him, God healed him." This expression is found in a number of places in his works.

In 1541 appeared his book, great in size as well as in matter. He gave a complete discussion of surgery as it was then known together with many illustrations. The excellence of the latter and the fullness of the index at the end of the book surprise the modern reader. In this work we find his discussion of the generation of man and a chapter on monsters. Some of these, as pictured in his book, might astonish the modern teratologist and seem to have been imagined, as Barry Anson puts it, by a combination of Genesis and genetics. Among the figures shown are some which resemble abnormalities familiar to us all but others bear no resemblance to fetal abnormalities as we know them.

In this work, in Book 25, Chapter XLVIII, appears an account of a woman who had a protrusion from the introitus, seemingly a prolapse. This was treated by an operation which appeared to be a vaginal hysterectomy. The woman died three months later, from a pleurisy as Paré says, and he was able to obtain an autopsy which disclosed the fact that no uterus was present. Apparently the operation must have done away with it. He pictures pessaries, both ball-shaped and in the form of rings. Remedies are given for vaginal and cervical conditions. An illustration appears of a speculum which is mechanically ingenious although less effective for the purpose for which such an instrument is used than those of today.

The cruelty of the hot oil and heated iron used for stopping hemorrhage repelled him, and we may assume that some of the obstetric procedures of his day must have been equally offensive. In 1549 we find his first reference to an obstetric subject. It is contained in a book published in that year and entitled "*Brief Anatomic Collection: with the method of setting bones: and of extracting infants, dead as well as alive, from the bodies of their mothers.*" This was printed in Paris at the sign of The Fat Hen. As he had to leave soon after this was submitted for publication, the errors in the text were corrected with the pen. In this work we find the first reference to podalic version. In 1573 he published a book entitled "*Dix Livres de Chirurgie avec le Magasin des Instrumens necessaires a icelle*" (10 books of surgery with the necessary instruments). Here we find pictured a few of the hooks and curved knives employed to terminate impossible labors. Forceps were not to appear for another century, and we may well imagine that these implements and the procedures carried out with them may have impelled him to seek a better way of terminating these cases.

While only a small part of his time was devoted to obstetrics, and this necessarily during that portion of his life which was not filled with

military duty, he performed a great service to our specialty. His revival of version added tremendously to the resources of the accoucheur and was a great service to his patients, who before his time could only be delivered by traumatic destructive operations in the event that labor did not end spontaneously. His discussions of generation and of monsters were the first of which I know which directed attention to these subjects. In his discussion of generation he could, of course, give no accurate description of fertilization of the egg as the pioneer work in microscopy of Hooke in England, Malpighi in Italy and Leeuwenhoek in Holland was not to come for another century.

Here was a man of enormous energy and industry, unusual ability, who rose from humble beginnings through his own efforts to a commanding position in his profession and who contributed greatly not only to surgery in general but to obstetrics as well. We must regard him as one of the builders of the foundations of present-day gynecology and obstetrics.

He had some notable contemporaries, for Montaigne and Rabelais lived in France at the same time. He and Rabelais lived quite close together for a time, and it is strange that we find no mention of him in any of Paré's works. Indeed, he is said to have been a parishioner of Rabelais for a time. The French in which Paré wrote is quite the same as that of Rabelais. One whose knowledge of the language is sufficient to enable him to read easily the French of four hundred years ago will find great pleasure in reading him in the original.

He lived to old age and apparently his vigor of mind and his boldness remained with him, for in 1590, at the age of eighty-one, we find him addressing the powerful Archbishop of Lyon, during the siege of Paris, when there was much suffering among the people, and demanding that he use his influence for peace. That he attained a high position, not only professionally but also in society, we may know from the fact that the children of his second marriage had noblemen for god parents, the Duc de Nemours and the Marquis d'Elbeuf acting as such. He served three kings and Henri the second, the ablest of them, regarded him as a great friend. The successor of this king, Henri the third, a man of much less ability, he served with equal faithfulness evidently believing that duty was duty no matter who happened, by the accident of birth, to be the sovereign.

One of the most distinguished of the pupils of the famous master, Paré, was Jacques Guillemeau. He was born in 1520 and died in 1613. Other surgeons who had to do with his early training were Riolan and Courtin but of all his teachers, Paré left the deepest imprint. He had the advantage, lacking in the case of Paré, of an ample early education, and he was well versed in the ancient languages. It was he who translated the works of Paré from French into Latin in 1582. He had a love for belles-lettres and in every way seems to have been a scholarly man whose first interest was medicine. While he excelled Paré in learning

outside the field of surgery, and while he was a faithful and skillful follower of the teachings of his master, we find no evidence in his career of the bold, restless, scientific pioneer, seeking new truths and eager to try new methods. He took what he had been taught and used it excellently but added nothing to it, except a work on the diseases of the eye. This, however, was not too highly considered by his contemporaries and by later authorities is not regarded as an outstanding piece of work. In obstetrics, he took the operation of version, which he had seen carried out by Paré, and used it to good purpose. It is said that he saved the daughter of Paré by version when she was bleeding seriously.



Fig. 2.—Jacques Guilleméau.

In 1609 he published a book entitled *L'Heureux Accouchement des Femmes* and in 1621 another entitled *De la Grossesse et Accouchement des Femmes, du gouvernement d'icelles, et moyens de subvenir aux accidens qui leur arrivent* (*The Pregnancy and Delivery of Women, Their Management, and the Means of Dealing with Complications*). This last was his best work.

Guilleméau favored version but condemned cesarean section, with which opinion we should probably agree, if we were to work under exactly the conditions of his day. He states that "the worst things which can happen to a woman in labor are hemorrhage and convulsions. If either one occurs, immediate delivery is needed." In speaking of the loss of patients from obstetric accidents he says, "We have seen, to our great regret, death occur because of the stubbornness of relatives and friends, or even by the fear of doctors and surgeons, who



temporized in the hope that bleeding would cease." This may awaken memories in the minds of many of us who have met this sort of thing in our professional careers.



Fig. 3.—The pregnancy and delivery of women. Guillemeau, 1620. (Courtesy of Surgeon General's Library.)

His life resembles that of Paré in that his professional experience began in the Hôtel Dieu where he served as a young man at the outset of his career and in which he, for a time, did military duty. While the inventive genius and initiative of his master were absent, he must still

be accorded a place among the real builders of our specialty, for he continued the work of Paré in adding version to the resources of the accoucheur, both by his work as a widely known practitioner and as the author of two authoritative books.

In the seventeenth century appeared a leader and teacher of the art of obstetrics, Mauriceau. He obtained a large early experience in the Hôtel Dieu in Paris. Details concerning his life are difficult to obtain but he seems to have carried on a very large practice in Paris and to have served extensively in the capacity of what we should today term



Fig. 4.—Mauriceau. (Author's collection.)

an obstetric consultant. His basic principle was that an exact knowledge of the anatomy of the reproductive tract and its function must underlie any obstetric teaching. With this statement none of us will disagree. In his own published work, however, we may regret that he did not make use of anatomic investigations of his own rather than follow the old dissectors. Fresh material of his own providing would have been a great addition to his valuable work. In 1668 appeared his book, containing the description of the reproductive anatomy, obstetric technique, management of the puerperium and of the newborn. This book went through a number of editions, the first being in Latin, in which the edition of 1681 was also printed. The edition of 1694 appeared in French and to this was added a large number of case reports. Some

of these had been published before but by the time this edition appeared the number had grown to 700. He exhibited a commendable broad-mindedness in these reports for he included a number of cases the outcome of which had not been favorable. These he characterized as things to be avoided, those which were successful being things to imitate.

He condemned cesarean section and made extensive use of version. He illustrates in his book a number of knives and hooks which he used when he was compelled to make use of a destructive operation. Among

FRANCISCI  
MAURICEAU  
ARTIUM MAGISTRI.  
ET ANTIQUI PRÆPOSITI  
MAGISTRORUM CHIRURGORUM  
PARISIENSII SOCIETATI,  
DE  
MULIERUM PRÆGNANTIUM,  
PARTURIENTIUM;  
ET  
PUERPERARUM MORBIS  
TRACTATUS

*Tradens veram optimamque methodum adjuvandi Mulieres  
in partu naturali, & medendi cuilibet partui contra naturam,  
morbisque infantium recens-natorum : cum accurata descri-  
ptione omnium mulieris partium generationi inservientium;  
adjunctis multis figuris æri egregie inculptis.*

*Opus Chirurgis utilissimum, Obstetricibusque omnibus ad obstetricandi  
artem perfecte discendam valde necessarium.*

MCM

PARISIIS,

Apud AUCTOREM, in medio via dictæ des Petits-Champs, sub signo boni Melici.

M. D. C. L. X. X. X. I.

*Cum Privilegio Regis, & Approbatione Domini Archiatrorum Comitii.*

Fig. 5.—First Latin edition of Mauriceau, 1681. (Author's collection.)

his case reports we find, in observation 26, the account of his meeting with Chamberlen and of the latter's vain attempt to deliver a rachitic dwarf who was under Mauriceau's observation. He concludes the report with the observation that the English obstetrician had gone back to London from Paris where there were more skillful accoucheurs than he. This unfortunate patient died of a ruptured uterus the next day and autopsy showed numerous wounds of the uterine wall made by the forceps, which as Mauriceau explains, had to be introduced without the guiding hand as the pelvis was so small. The experience caused him to devise an instrument he called the "tire-tête" by means of which he believed that such cases could in future be managed. The modern

operator, looking at the drawings of the instrument, may perhaps have some doubt as to its efficiency. One may wonder what the effect upon obstetric progress would have been if the case given to Chamberlen had been a more favorable one and had succeeded. If Mauriceau had accepted the instrument, with his commanding position and his great energy, it would have been made known to the medical world far sooner than it was. We cannot commend Chamberlen for trying to sell the forceps, but this operative failure withheld the help it could give to many women for years.

Chamberlen was sufficiently impressed by Mauriceau and his work that he translated his book into English. The English version was published in London in 1716.

He was acquainted with placenta previa and reports a number of cases. He did not recognize the exact state of affairs, however, for he believed that the placenta had become loosened from its normal seat and had preceded the child into the lower part of the uterus.

Although he was an acute observer and a skillful operator, we are told that even Jove may nod, and so we find him denying the work of de Graaf and refusing to believe the existence of the egg in the ovary. He carried his skepticism so far as to deny tubal pregnancy although he saw at least one which he described and illustrated in Book I, Chapter 5. He believed that the swelling in the tube was a hernia of the uterus. I cannot take the time to go into all his explanations of the findings in this case but he goes into the matter in detail and indicates how he believed the fetus escaped through a tear in the side of the uterus.

His greatest service was in definitely establishing the technique of breech extraction, particularly of the delivery of the aftercoming head. His description of this operation in Chapter 13 of Book II should be read by every obstetrician as it is one of the important contributions to our art. His name alone should be attached to this operation without the addition of those of others who merely "re-discovered" what had already long been known.

As many great men, he also had a few foibles, which we may easily forgive. He seems to have had a rather active appreciation of his own worth, which, the circumstances being what they were, is far less of a fault than if he had been a mediocrity.

In the frontispiece of the edition of 1681, we find, under a small portrait of himself, the words, "*Me Sol, non Umbra, regit.*" His finger points toward the sun. The implication seems to be that he thought some of his contemporaries were less happy than he in their choice of a source of inspiration. In his case reports, too, we occasionally find an expression of the same feeling when he remarks that he did this or that to the great amazement of the midwives and surgeons present.

None the less, he was a great man and perhaps many of us have seen men who have had the same fault without as much justification as had Mauriceau.

Professional differences of opinion in the seventeenth century brought forth a greater freedom of expression than we today feel is proper. Mauriceau spoke his mind in plain terms in a number of instances. The following, concerning the work of one of his contemporaries, Viardel, may serve as an example: "The notable error of a modern author, whose book deserves rather to be sent to the butter sellers and grocers of the public market to be used as wrapping for their merchandise than to be distributed to the public to be the cause of dangerous consequences because of his bad precepts, and because of the crass ignorance of the author, whose method is pernicious."

The second half of the seventeenth century was distinguished by the appearance of a number of able workers. Mauriceau was the greatest but other lesser suns shone in the obstetric sky. Louise Bourgeois followed the work of Paré and Guillemeau and insisted on the advantages of version and rapid intervention in cases of hemorrhage. She also insisted on the possibility of delivery in face positions. Pineau studied the anatomy of the pelvis and drew attention to the abnormalities caused by rachitis.

The most notable of those who appeared at this time was Paul Portal. The date of his birth is not exactly known but was probably 1630. There is a hiatus in the public records of Montpellier, where he was born, of about ten years. During this time Portal was born. He entered the Hôtel Dieu in 1650, admission to which was not permitted under twenty years of age. One of the best sources of information concerning him is a thesis submitted for the doctorate in medicine in Paris in 1900 by an aspirant named Maruitte. As the thesis was passed upon by a committee presided over by Pinard we may assume that it is essentially correct. Of his early life we know little but that he became what we should term today a resident in the Hôtel Dieu in 1657, leaving it in 1663. The teacher of whom he speaks the most was René Moreau, and to him he dedicated his book. Copies of this are rare today and Maruitte speaks of the difficulty he experienced in obtaining a copy to use in preparing his thesis. He finally used one which had belonged to Tarnier. I have not been able to find a copy of the original French edition but did find one of the English edition printed in London in 1763. The French title was *Pratique des Accouchements* while the English edition bore the title *The Compleat Practice of Men and Women Mid-wives*, or the *True Manner of Assisting a Woman in Child-bearing*. The book itself is quite short and entirely clinical in character. It is accompanied by a number of observations in the manner of Mauriceau's book, although the number of cases cited is less. He intended it to be a record of his own experience and says that it is to be "not only what authors have written but what I have seen." This manifests a healthy



spirit of observation which contrasts with the writings of many authors who are content to take what has been written by others and to repeat it as their own and thereby prolong error.

We find in the records of his work evidence that he was an excellent clinician. His judgment as to the management of some of the complications of labor would be agreed to by most of our modern teachers. His advice against attempts to hasten labor may well be listened to today and his warning against interference without adequate cause resembles some of those which have been uttered in the past few years. His attitude toward medical literature is shown by his statement that "books would be of more value if they reported what has been seen and done, these things being told with sincerity and good faith."



Fig. 6.—Paul Portal.

Portal differed from Mauriceau in that he was pacific and not given to forceful expression of differences of opinion. He commonly refers to his contemporaries as skillful surgeons and able physicians, and we find no severe criticisms of their work. He did not enjoy a practice made up largely of the wealthy or socially prominent; most of his patients, as Maruitte tells us, being the wives of tailors, shoemakers, grocers, and so on. However, clinical experience is as well, if not better, gathered in the lower ranks of society, and we know that the "fashionable physician" in many large communities today is often not a contributor to the science of medicine.

He genuinely contributed to our specialty. He recognized, as Mauriceau and Paré had not, that the placenta may attach elsewhere than

in the corpus uteri and therefore seems to have been the first to appreciate the true nature of placenta previa. Mauriceau had taught that face presentation, when left to itself, will often terminate happily but the lesson had not been completely learned. Portal, who re-emphasized this important fact, did much to fix it in obstetric teaching.

Among his case reports is one of a hydatidiform mole of which he gives an illustration. His description is accurate. He speaks of the vesicles as resembling white currants, or the spawn of frogs. He took the specimen home with him for study and invited M. Auzon, of the Faculty, to see it with him. He does not give the date of this observation, but, as in many of his case reports, he gives the name of the street in which the patient lived. The patient recovered.

He also pointed out the possibility of accomplishing a breech delivery by means of one foot only. The extraction already described by Mauriceau is spoken of, the technique given, and he used it himself.

His book, which was overshadowed by that of Mauriceau, which was still recent, and which went through a number of editions, did not receive the attention it merited. Nonetheless, he must be reckoned among the builders of our branch of medicine.

Among the teachers of the eighteenth century two figures stand out, those of Levret and Baudeloque. André Levret was born in 1703 and died in 1780. He devoted himself with enthusiasm to the improvement of obstetric technique. In 1739 he received a legacy from a patient, a man, by the way, whom he had cared for over a considerable period of time and who showed his appreciation by leaving him a sum sufficient to free him from the need of earning his entire living. He was on terms of great friendliness with Louis, chief surgeon of the Salpêtrière and later permanent secretary of the Royal Academy of Surgery, with whom he made a number of reports. After the death of Jard, accoucheur of the court, Levret followed him in this office. Numerous students came to him from near and far, through whom, together with his writings, his name and teachings became widely known in his own country and elsewhere. He was particularly interested in improving the technique of operative obstetrics and in 1747 devised a forceps by the use of which he hoped to obviate the need of always locking the instrument at the same point. This he accomplished by the use of three holes in the shank, through any one of which locking could be accomplished, the blades being joined at the desired point by means of a peg held in place by a small rod. The movable point of locking, in principle, is not unlike that of the forceps of Kielland, which appeared about 165 years later. The instrument still left something to be desired and in 1748 he added the pelvic curve which since his day has never ceased to be a part of the obstetric forceps. The drawings of these instruments are accurate and would serve as excellent specimens of mechanical drawing today. This modification of the forceps constitutes his great addition

to the field of operative obstetrics and one which remains with us still and which will probably never be displaced.

The mechanical ingenuity of the man may be demonstrated by the drawings of his three-bladed instrument designed for the extraction of the head left in the uterus after attempts at breech delivery, an accident seemingly more common then than in good clinics today. His sheathed

## OBSERVATIONS

SUR

LES CAUSES ET LES ACCIDENS

DE PLUSIEURS

ACCOUCHEMENS

LABORIEUX,

AVEC DES REMARQUES

Sur ce qui a été proposé ou mis en usage pour les terminer;  
& de nouveaux moyens pour y parvenir plus aisément.

Par M. A. LEVRET, du Collège & de l'Académie  
Royale de Chirurgie, Accoucheur de Madame la  
Dauphine, &c.

Troisième Edition, revue & corrigée.

Alexandre  Viennois

A PARIS,

Chez P. ALEX. LE PRIEUR, Imprimeur du Collège  
& de l'Académie Royale de Chirurgie, rue  
Saint Jacques à l'Olivier.

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M. DCC. LXII.

Avec Approbation & Privilège du Roi.

Fig. 7.—The treatment of difficult labor, Levret, 1762. (Author's collection.)

hook (*crochet à gaine*), was another device of a mechanical mind. That the two latter instruments have not survived is no criticism of the outstanding value of his addition to the forceps. This improved instrument decreased the number of destructive operations. Time does not permit the discussion of all of his contributions to the art of operative obstetrics, but Siebold's statement that he must be regarded as the founder of a rational teaching of operative obstetrics seems just.

His book, entitled *Observations sur les causes et les Accidens de plusieurs Accouchemens laborieux avec des remarques sur ce qui a*

*proposé ou mis en ouvrage pour les terminer, et de nouveaux moyens pour y parvenir plus aisément* (observations upon the causes and complications of various difficult labors, with remarks upon that which has been proposed or used to terminate them, and concerning new means for accomplishing this more easily) appeared in 1747. A number of editions followed, a third revised one in 1762 and a fourth in 1770. Another notable work was his *L'Art des accouchemens démontré par des principes de physique et de mécanique pour servir d'introduction et de base à des leçons particulières* (obstetric art demonstrated by physical and mechanical principles to serve as introduction and as base for private lessons), which was published in 1761.

An anecdote survives according to which, when he came to care for the wife of the brother of the king during labor, her husband, known as "Monsieur" during the days of the Bourbon kings, condescendingly said to him, "this case will make your reputation." Levret at once replied, "If my reputation were not already made, I should not be here."

Among his publications is one on polyps, which appeared in 1749 and which does not confine itself to polyps of the uterus but includes those of the throat and nose.

He was a great teacher who was not only a skillful operator but who also considered the mechanical problems which delivery sometimes presents and who went about solving them in a logical manner. His great addition to the art of the forceps will probably remain permanently in the literature of obstetrics.

The second great figure of the eighteenth century was Baudelocque. He was born in the town of Heilly, in Picardy, in the Department of the Somme, in 1746. His medical studies were carried on in Paris where he worked especially in anatomy, surgery, and obstetrics. His teacher in obstetrics was Solayres with whom he became very friendly. On one occasion Solayres, who became ill, had Baudelocque take over an unfinished course and complete the instruction. After the death of Solayres, Baudelocque continued teaching. He became a member of the "College de Chirurgie" in 1776, his thesis being entitled "*An in Partu propter Angustiam Pelvis impossibili symphysis ossium Pubis secunda?*" I have not been able to find a copy of this, but it is said to have placed a proper evaluation of this procedure before his countrymen. When the Faculté de Medecine and the College de Chirurgie disappeared the École de Santé was founded and Baudelocque and Leroy became teachers of obstetrics. In 1798 he became Chief Surgeon and Accoucheur of the newly built Maternité and began the teaching of midwives. He had the confidence of the public and toward the end of his life Napoleon named him First Accoucheur of the Empress. He did not wholly escape vilification, as many eminent men have not, and was attacked in court after the death of a patient following delivery, and this through the action of a confrere named Sacombe. Baudelocque was acquitted while his colleague was fined 3000 francs. French justice in the

eighteenth century seems to have possessed an acuter vision than some which we have known since that time. The memory of this affair embittered him until the end of his life. He died in 1810.

He gave much attention to the mechanism of labor and to deformities of the pelvis and devised a "Compas d'épaisseur" which was simply the beginning of the pelvimeter. While he made use of version extensively, he by no means scorned the forceps and devised one of his own which was somewhat longer than that of Levret. He was concerned in establishing definite conditions under which the instrument should be used. The problem of too frequent interference seems to have been present then as now.

**PRINCIPES**  
**SUR L'ART**  
**DES ACCOUCHEMENS,**  
**PAR DEMANDES ET REPONSES,**  
**EN FAVEUR DES SAGES-FEMMES**  
**DE LA CAMPAGNE:**

*NOUVELLE EDITION, revue, corrigée,  
augmentée & enrichie d'un grand nombre de  
Planches en taille douce, propres à en faciliter  
l'étude;*

PUBLIÉE PAR ORDRE DU GOUVERNEMENT:

*PAR M<sup>r</sup> J. L. BAUDELOQUE, Membre du  
Collège, Conseiller du Comité perpétuel de l'Académie  
royale de Chirurgie de Paris...*



A PARIS, -  
Chez MÉQUIGNON l'aîné, Libraire, rue des  
Cordeliers, près des Écoles de Chirurgie.

**M. DCC. LXXXVII.**  
*Avec Approbation & Privilège.*

Fig. 8.—Text Book for Midwives by Baudelocque. (Author's collection.)

He did a great work in the teaching of midwives. Most of these women were sent by their departments, being chosen by the prefects, for instruction so that they might return home and serve their own communities and hospitals. These schools of midwifery were useful institutions in the eighteenth century and the famous women who taught at that time worked in them as head midwives. Madame La Chapelle and Madame Boivin are the chief examples. Unfortunately, the time available will not permit my speaking of them at length.



Baudelocque had about 150 of these students a year. They were taught far more completely than is the case with their sisters of today, for they were taught to do the operation of version and that of forceps. This was accompanied by instruction in the fundamentals of obstetrics and embraced even vaccination, bleeding, and something of pharmaceutical botany. The public institutions were so taken up with the teaching of midwives that physicians wishing to increase their knowledge of obstetrics had to go to smaller private institutions. The Maternité, in Baudelocque's day, had about 2000 births a year, which were used solely for the teaching of the midwives. Since these women, after their course of instruction, were scattered over all of France, Baudelocque's principles obtained a wide recognition.

When many of us were students there were published small books on many subjects which consisted of question and answers. These were known as quiz compends. Whoever published the first one may have thought he had an original idea but in 1775 Baudelocque published a book for midwives constructed on exactly this principle. This appeared in various editions and in 1787 the Government had 6000 of them printed. In 1806 another edition was needed. Two more followed and translations were made into German and Italian.

Baudelocque carried the obstetrics of the eighteenth century over into the nineteenth, and, as Cutter puts it, integrated the best French teaching with the rapidly developing English school led by Smellie. His teaching was upon sound principles and his training of midwives, whatever we may think of them as a class today, probably was the means of bringing to a great number of French women better care than they would otherwise have had. While other able men worked in the eighteenth century Levret and Baudelocque seem to stand apart from the rest and to have accomplished more than any other two.

Paré seems to have been the one to first attack the problem of delivery in difficult labor without in every case sacrificing the infant. Before his day, medicine had slumbered for centuries. While his own work consisted in the re-establishing of the operation of version, he succeeded in bringing the question of the management of difficult labor before the medical world and all the progress which has brought us to where we are today began with his work. Baudelocque regarded Mauriceau as the first real accoucheur and after him came a group of brilliant workers whose work remains in the structure of modern gynecology and obstetrics. In the nature of things but little of the work of these men was gynecologic, for aseptic surgery was still far away. Their work was fundamental; they laid some of the great foundation stones upon which later workers might build. The French nation today has fallen upon evil times and no one knows when, if ever, it may regain something of its former intellectual leadership. But in the days in which lived the men of whom I have spoken the French were a great people and their contributions to science were of great value. We

today are finishing the structure which they, and their co-workers in other lands, began. Most of the great principles have been established but much remains to be done in the perfection of technique and the furthering of knowledge along physiologic, biochemical, and endocrinologic lines. In the progress which has been made in the last half century, the Fellows of this Society have borne a notable part. It is certain that the contributions of the Fellows of the future will solve some of the remaining problems. At a time in which the resources of the Nation and the lives and careers of our young men are being devoted to the struggle against the forces of destruction, we are permitted, because of the age of most of us, to continue the constructive work of medical science. May we so conduct ourselves that not only we may follow well the example set us by some of those who have worked in centuries gone before but that we may maintain our Society in that high place in which our eminent predecessors have left it.

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## STUDIES ON HEAD MOLDING DURING LABOR\*

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IT IS a well-known fact that during labor the size of the area enclosed by the circumference of the fetal head slowly decreases through flexion and molding. For this reason investigators, using roentgen methods of mensuration, have difficulty in finding an accurate method of determining head size and active research continues. Other workers doubt if this problem can be solved and believe that obstetrical prognosis, for borderline cases at least, will continue to depend upon a trial of labor to disclose the true significance of the supposed degree of existing disproportion between the head and the pelvis. We have been interested in this problem of cephalometry for some time and believe that ultimately methods will be devised which will bring about greater accuracy in prognosis. In the meantime, a chance observation has directed our interest toward the question of head molding. This observation suggested the possibility that certain changes might occur in the base of the skull, a region hitherto considered too rigid to be modified significantly by the forces of labor. The present investigation has developed from this original observation.

### METHODS OF STUDY

At birth, both in the molded head and the head delivered by cesarean section, the coronal and lambdoidal suture lines are either closed or show very slight separation (Fig. 1). A separation at these suture lines begins shortly after birth and increases rapidly in the postnatal period (Fig. 2.). This postnatal separation causes an increase in certain diameters (occipitofrontal) in addition to the increase or decrease produced in other cephalic diameters by the disappearance of the physical effects of molding. For this reason, molding cannot be studied by comparing the shape of the head at birth to the shape assumed later in the postnatal period.

Another factor which must be considered in the study of molding refers to the bending caused by the squeeze effect of labor. The magnitude of the changes caused by the squeeze effect of labor upon the head is probably greater than is realized. For instance, we have found that the biparietal diameter immediately increases by at least one-half

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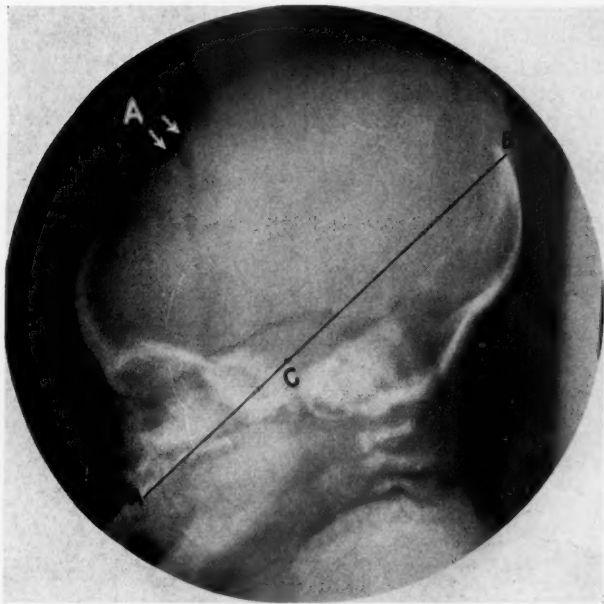


Fig. 1.—Lateral view of a markedly molded head shows closure of the coronal "A" and lambdoidal suture lines. Forward displacement of the occipital plate is apparent with overlapping at the lambdoidal suture, because, in the postnatal period, there is no compression of the parietal bones to restrict the degree of this movement. Note asymmetrical separation of lateral suture line (retouched).

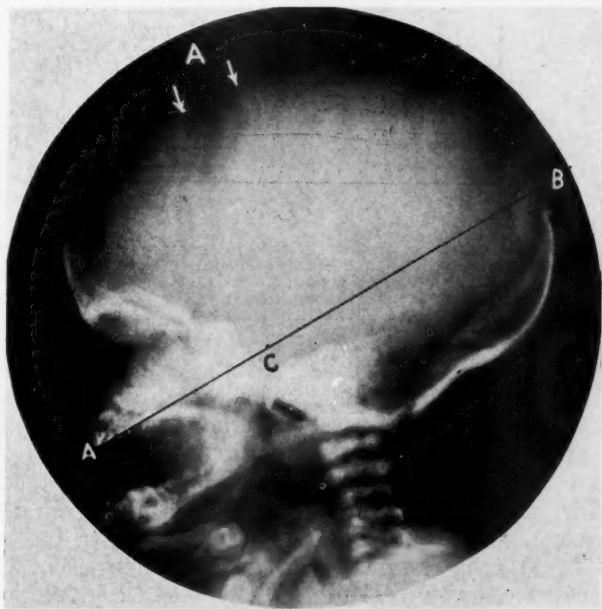


Fig. 2.—Lateral view of the example shown in Fig. 1 eleven days after delivery reveals separation of the coronal "A" and lambdoidal suture lines. Compare the level of the tip of the occipital bone to the maxillary-spheno-occipital line, ACB, in the two views.

centimeter as soon as the head is born. The spring effect of the constriction of the head by the maternal passages no doubt disappears very rapidly after birth, so that it is important to obtain the roentgenologic examination as soon as the condition of the newborn child permits. Examination of the newborn child immediately after birth reveals a mobility of the bones of the vault and even of those constituting the base which cannot be demonstrated to advantage within one hour.

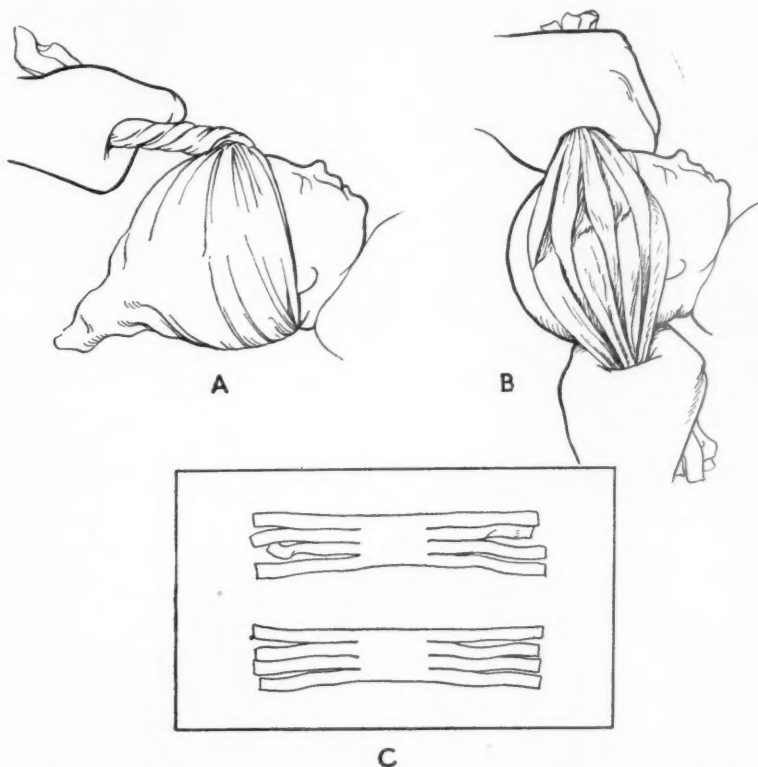


Fig. 3.—Methods of compression. A, The towel compression binder used to simulate the squeeze effect of labor upon the living infant. The constriction force was not measured except by a crude index of six and one-half turns of the towel. B, Method of compression binder used upon stillborn heads. A strong constriction force, not measured, was used. C, Diagram of the interlacing type of binder used in method B.

Although this fact was soon realized, it was found to be impossible in most instances to obtain the roentgenologic examination within the first hour of life because it was necessary to allow the infant to recover from the effects of delivery and time was consumed in transit to the roentgenological department for the examination.

In an effort to simulate the squeeze or bending effect of the forces of labor, a compression binder was used as illustrated in Fig. 3. This method of towel compression exerts its maximum effect between the brow and the suboccipital region. The amount of compression used was not measured except in a gross manner as expressed by six and one-half turns of a towel.

We have, therefore, used the following two methods for determining the effect of labor on the head.



1. The comparison of films obtained immediately after birth by cesarean section with those obtained with heads delivered through the maternal passage.
2. The comparison of films obtained from molded heads before and after the use of a compression binder.

Lateral roentgenograms and, in a few instances, anteroposterior exposures were obtained as soon after delivery as possible. During the earlier part of the investigation a target-film distance of six feet was used in 33 case studies. Later a shorter target-film distance was employed in approximately seventeen cases. Likewise a shorter target-film distance was used in approximately fourteen cases which were subject to compression to simulate the squeeze effect of labor.

Although 64 complete roentgenologic studies were made on newborn infants, several factors existed which limited the number of cases suitable for study purposes. In most instances, the physical evidence of molding in the vault and skull base was slight because no disproportion existed between the head and pelvis. Good examples of molding occur in premature infants due to soft part compression and in average-sized infants due to the presence of definite degrees of disproportion. In the latter circumstance the disproportion is overcome by effectual labor in conjunction with adequate flexion and molding. At the present time, cesarean section is employed not infrequently for moderate degrees of disproportion and the head is not given a chance to mold. For these reasons the number of extreme examples of molding adequate for study purposes in a series of sixty-four cases is not great. In not a few instances a case study was excluded because it is difficult to maintain a newborn child in a fixed position long enough to obtain a perfect lateral view with satisfactory superimposition of the orbital ridges, the petrous portion of the temporal bones, and the coronal and lambdoidal sutures. This difficulty is increased with any attempt to use compression. A compression binder was used in 14 instances, and although the observations reported in this presentation could be demonstrated in all these cases, satisfactory lateral views from examples of extreme molding were obtained in only two instances in living infants, one of which is illustrated in Figs. 15 and 16.

#### A. CEPHALIC DIAMETERS

It is necessary here to define certain head diameters which are not illustrated in most obstetrical texts. The well-known occipitomenal diameter is not satisfactory for the purpose of this study inasmuch as it is impossible to control the position of the lower jaw during the roentgenologic examination. We have chosen a diameter which is somewhat comparable to the occipitomenal diameter and which extends between the upper incisor tooth and the midpoint of the parietal bone along the median sagittal suture (Fig. 4). This distance is termed the "maxillary-vertical diameter," *CB*. A line drawn from the tip of the upper incisor tooth through the tip of the dorsum sellae and extended to the circumference of the skull posteriorly may be termed the "maxillary-spheno-occipital diameter," *CAE*. It is also desirable to use a single diameter to express the distance between the vault and the base of the skull. Scammon and Calkins have described the vertical auriculo-vertex distance extending from the midpoint of the parietal bone along its upper free border to the plane of the external auditory meatus.

It is true that this landmark may be readily identified in most lateral roentgenograms, but the dorsum sellae is a more definite and easily recognizable landmark. Accordingly, a "sphenovertical diameter," *AB*, is described, extending from the midpoint of the upper border of the parietal bone to the dorsum sellae. Another diameter which is discussed in this presentation extends from the midpoint of the upper border of the parietal bone to a point in space between the tips of the superimposed petrous portions of the temporal bone. This distance is termed the "midpetrovertical diameter," *BD*. It will be pointed out later that the angle diverging from the suture line between the sphenoid bone and the basioeciput is modified by molding. This angle is designated as the "sphenopetrous angle," angle *F*, Fig. 4.

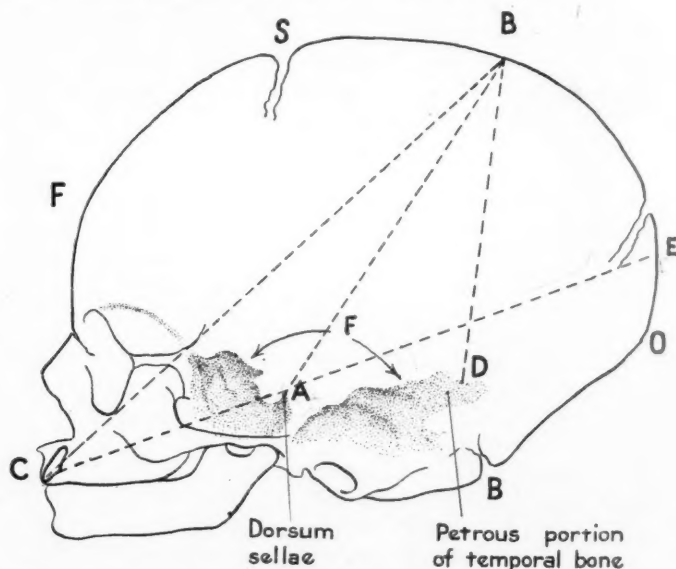


Fig. 4.—Diameters of the fetal cranium modified by molding and applicable for the study of lateral roentgenograms. *CB*, Maxillary-vertical diameter. *CAE*, Maxillary-spheno-occipital diameter. In the molded heads the tip of the occipital bone is usually at least from one-half to one centimeter above this line. Immediately after birth the tip begins to recede toward the level of this line, and in adults, it is depressed below this line. *AB*, Sphenovertical diameter. *BD*, Midpetrovertical diameter. *FO*, Occipito-frontal diameter, *SB*, Suboccipitobregmatic. *F*, Sphenopetrous angle.

A study of the base of the skull (Fig. 6) draws attention to two suture lines which may allow bending within the skull base; the suture line between the sphenoid and petrous portion of the temporal bone and basioecipital bone "A," and the suture lines between the basioecipital bone and the occipital condyles "B."

As an aid in explaining an interesting mechanism of locking which can be demonstrated at the coronal and lambdoidal suture lines, two transverse diameters are described which are relatively unimportant for any other purpose. These two diameters are termed the "anterior-inferior-biparietal" and the "posterior-inferior-biparietal" diameters (Fig. 5). The former extends between the anterior-inferior border of the parietal bones at each anterior lateral fontanel. The latter extends between the posterior-inferior borders of the parietal bone at the

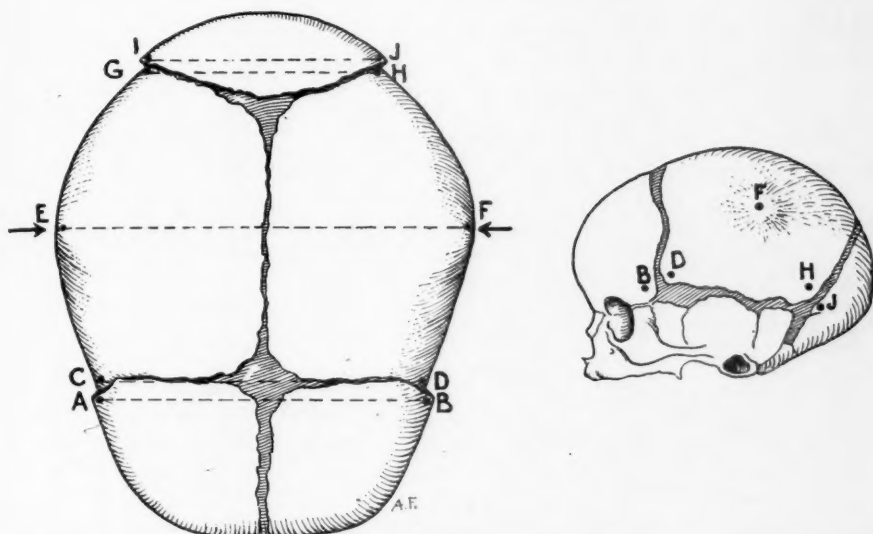


Fig. 5.—Diameters of the fetal cranium modified by molding. Vertical view. *AB*, Bifrontal diameter. *CD*, Anterior-inferior-biparietal diameter. *EF*, Superior-biparietal diameter. *GH*, Posterior-inferior-biparietal diameter. *IJ*, Bi-occipital diameter. Lateral view (insert) shows relative location of these transverse diameters.

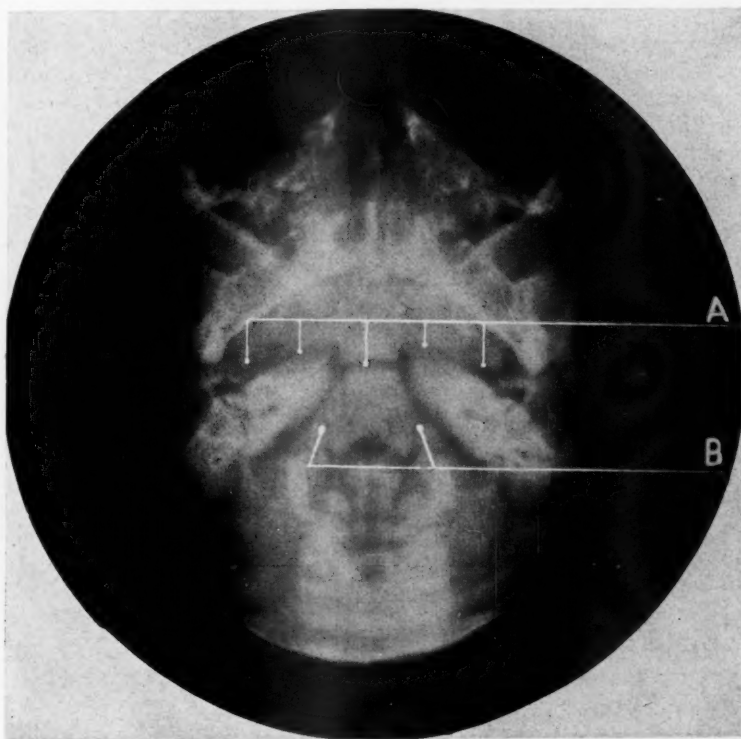


Fig. 6.—Important suture lines within base of skull. *A*, The suture line between the sphenoid and the petrous portion of the temporal bone and the basioccipital bone. *B*, The suture line between the basioccipital bone and the occipital condyles.

posterior lateral fontanel. When slight but uniform pressure is applied over each parietal eminence of a living newborn infant, all transverse parietal diameters are reduced in size and the median sagittal suture closes and may overlap. Under these circumstances, the anterior-inferior-biparietal diameter is shorter than the bifrontal diameter and the posterior-inferior-biparietal diameter is shorter than the width of the base of the occipital plate (bi-occipital diameter). This fact can be demonstrated easily in the newborn infant when pressure is applied at the parietal eminences. The lower third of the occipital bone overrides the adjacent border of the parietal bones and, in front, the frontal bones override the adjacent lower aspects of the anterior border of the parietal bones just above the anterior lateral fontanel.

#### B. METHOD OF FILM COMPARISON

Two fixed points, the tip of the dorsum sellae and the most prominent upper incisor tooth, were chosen within the head in order that landmarks around the circumference of the head as shown in a lateral roentgenogram may be compared to each other under identical conditions. For tracings and for comparison of any two individual lateral roentgenograms, the sharp tips of the dorsum sellae on the two films are first superimposed and the upper incisor tooth on one film is shifted to meet the line joining these two points on the other.

#### OBSERVATIONS

*A. Comparison of Molded and Unmolded Heads.*—It is possible to identify with accuracy on a lateral roentgenogram the following cardinal landmarks which are commonly displaced in molding; i.e., the points of origin of the occipito-frontal diameter, the posterior-superior angle of the frontal bones at the anterior fontanel, the midpoint of the free edge of the parietal bone along the median sagittal suture, the tip of the occipital bone, the posterior-inferior edge of the occipital condyles at the base of the skull, and the superimposed tips of the petrous portions of the temporal bone. The direction and degree of displacement of these landmarks may be appreciated by comparing their relationship in a series of heads demonstrating marked molding with a small series of unmolded heads delivered by cesarean section (Fig. 7). The small number of cesarean section cases used in this diagram is explained by the fact that these cases were selected from the series as a whole upon the requirements of the following factors; a six foot target-film distance, average size child, vertex presentation, and the employment of either the elective type of operation or operation after a very short trial of labor.

A study of this composite diagram draws attention to the following points which indicate the trend in molding and warrant more detailed consideration.

1. The most marked change caused by molding is indicated by the variations in the position of the mid point of the upper border of the parietal bone at the highest point of the vault (*C*, Fig. 7). This change indicates an increase in the maxillary-vertical and sphenovertical diameters.

2. The variations in the position of the midpoint of the vault of the skull (forward and backward range) would seem to indicate that the

parietal bones may be pushed forward or backward by unequal pressure applied at either the frontal or occipital regions of the head.

3. There is a definite decrease in the occipitofrontal diameter (*AE*, Fig 7).

4. The position of the posterior-superior angle of the frontal bone is fairly constant in molded and unmolded heads although there is slight elevation and slight backward displacement (*B*, Fig. 7).

5. The tip of the occipital bone is displaced slightly forward, but the more important change refers to the elevation of the tip in molded heads as compared to the cesarean section group (*D*, Fig. 7).

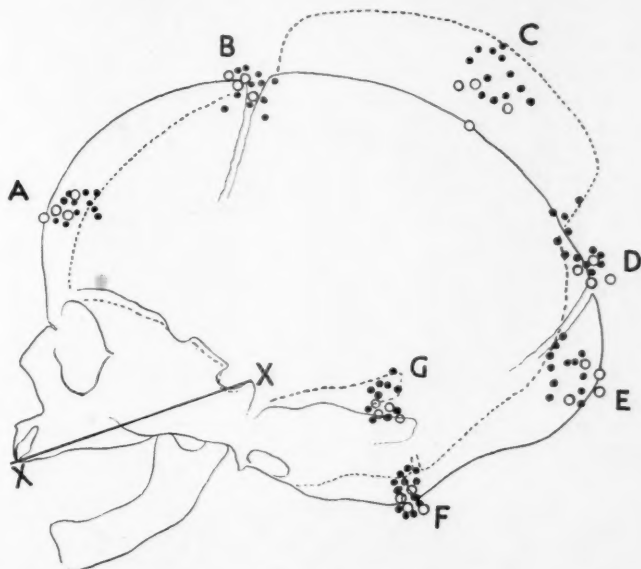


Fig. 7.—This composite diagram shows the variations in the positions of the following landmarks on the circumference of the fetal head. (*A*) the frontal origin of the occipital-frontal diameter, (*B*) the posterior-superior angle of the frontal bone, (*C*) the midpoint of the parietal bone along the vault of the skull, (*D*) the tip of the occipital bone, (*E*) the occipital origin of the occipitofrontal diameter, (*F*) the posterior-inferior extremity of the occipital condyles, (*G*) the posterior extremity of the superimposed petrous portion of the temporal bone. The films were compared by superimposing the tips of the dorsum sellae in each film. The upper incisor tooth on one film was adjusted until it coincided with a line joining the dorsum sellae and the upper incisor tooth on the other film (line *XX'*). The outline of the molded head and the unmolded example were traced from the case studies illustrated in Figs. 8 and 9. Molded heads, solid dot •; unmolded heads, small circle ○.

6. The tips of the occipital condyles are also elevated and this change may be associated with the elevation of the tip of the occipital bone (*F*, Fig. 7).

7. There is elevation of the distal aspects of the superimposed petrous portion of the temporal bones (*G*, Fig. 7) which reduces the size of the sphenopetrous angle.

8. The variations listed in five, six, and seven suggest that elevation of the entire base of the skull behind the sella turcica may occur in molded heads.

Before attempting to describe these changes in detail, it is of interest to determine the differences between these observations as listed and



our present concept of the mechanism of head molding. This concept has been described accurately by Holland as follows:

"The head consists of a nonrigid shell composed of loosely joined plates of pliable bones joined to a rigid base. The greatest bending of individual bones occurs in the parietal and frontals; the occipital bone

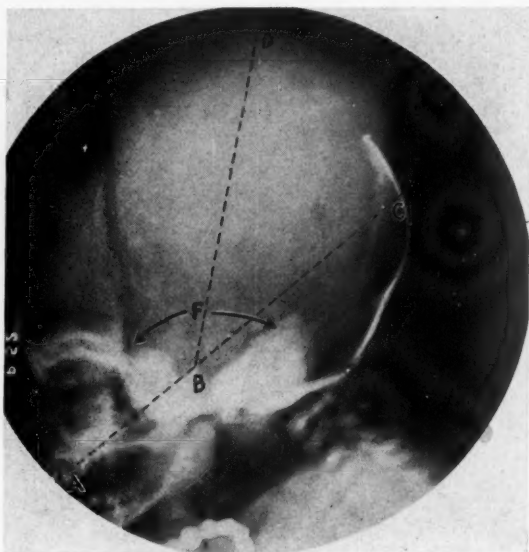


Fig. 8.—Lateral view of a well-molded fetal head. Note the acute sphenopetrous angle ( $F$ ), and the long sphenovertical diameter ( $BD$ ), and the long maxillary-vertical diameter ( $AD$ ).

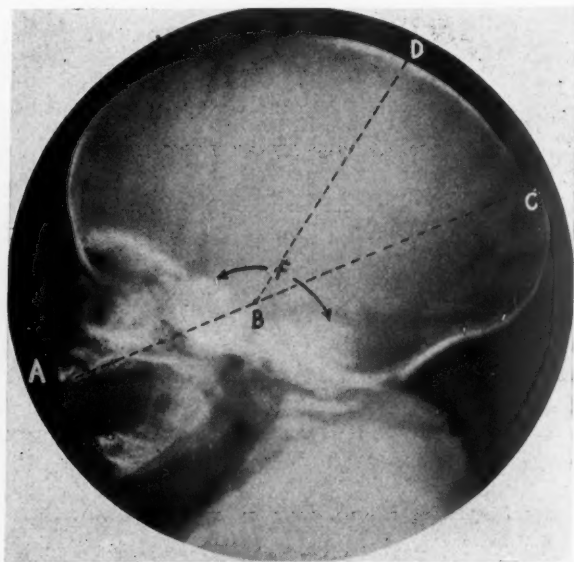


Fig. 9.—Lateral view of an unmolded fetal head delivered by elective cesarean section. Note the obtuse sphenopetrous angle ( $F$ ), and the short sphenovertical diameter ( $BD$ ), and the short maxillary-vertical diameter ( $AD$ ). The tip of the occipital bone is above the maxillary sphenoccipital line.  $ABC$ , in the molded head (Fig. 8), but in the unmolded example (Fig. 9), it is situated at the level of this line.

is more rigid and, although it becomes bent to a certain extent, confines itself chiefly to the role of moving backward and forward on the occipital hinge carrying with it the rest of the vault. The vault of the skull is plastic as a whole and can, within limits, change shape in most directions, but alterations in the shape of the head are chiefly dependent

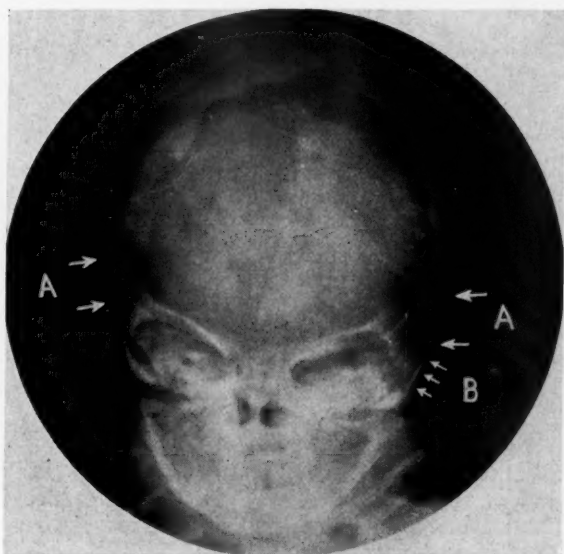


Fig. 10.—Anteroposterior view of case study in Fig. 8. Note the separation of the lateral suture (*A*) and the vertical position of the greater wing of the sphenoid and squamous portion of the temporal bone (*B*).

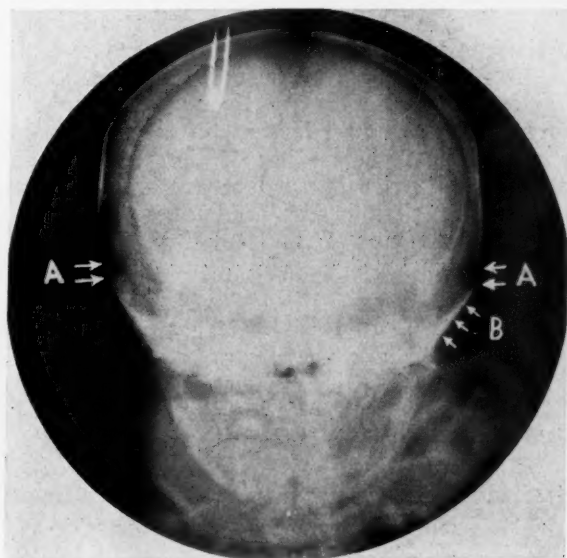


Fig. 11.—Anteroposterior view of case study in Fig. 9. The lateral suture is closed (*A*). The slope of the greater wing of the sphenoid and squamous portion of the temporal bone (*B*) is less vertical than in Fig. 10. In Figs. 10 and 11 observe the difference in curvature of the parietal bones in the coronal plane.

on the backward and forward movement of the occipital plate at the occipital hinge; bending of the bones is secondary to this and is, of course, a very necessary accompaniment."

Many years ago Ballantyne recorded important observations on head molding in a treatise on *Ante-Natal Pathology and Hygiene*. He questioned the concept that the occipital plate actually demonstrates the great mobility during labor which can be elicited in the newborn or stillborn infant. However, he also believed that "there is no molding of the basi cranii during labor, and it is fortunate for the fetus that there is not."

It will be observed that these descriptions differ chiefly in regard to the question of changes in the base of the skull.

The shift and displacement of anatomical landmarks suggested from the study of Fig. 7 are shown to advantage by the comparison of lateral and anteroposterior roentgenograms of a markedly molded head and a well-formed unmolded example (Figs. 8, 9, 10, 11). These two examples were chosen from the case studies used to construct the composite diagram illustrated in Fig. 7.

The sphenovertical diameter (*BD*) as well as the maxillary-vertical diameter (*AD*) are markedly increased in the molded head. The increase in these diameters can be caused by two factors: free bending of the parietal bones both in the sagittal and coronal axis, or elevation of the parietal bone; or by a combination of both. The free bending along the vault is apparent in Fig. 8 and the difference in contour of the parietal bones in molded and unmolded heads in the coronal axis may be observed by comparing Figs. 10 and 11. Elevation of the entire parietal bones can occur only through separation at the lateral suture lines at the base of the skull and separation to a considerable degree is shown in Fig. 10. Little attention has been directed to the lateral suture lines, and, in most obstetrical texts, diagrams devised to show the effects of molding fail to indicate separation at this point. Marked separation of the lateral suture line is not observed in fetal heads showing slight evidence of molding. It would seem that separation at this suture line occurs chiefly in extreme examples of molding when the stress of labor produces a greater increase in the sphenovertical diameter than can be gained by free bending of the parietal bones along the vault of the skull. Likewise unequal separation occurs at this suture line if the vault of the skull is displaced forward by unusual pressure applied to the occipital region of the head (Fig. 1).

The reduction in length of the occipitofrontal diameter is caused by several factors. First the frontal bone itself may be flattened by direct pressure if the bone is not too calcified (compare Fig. 1 and Fig. 8). The bending of the parietal bones along the sagittal suture line causes a slight reduction in width of each parietal bone which slightly reduces the occipital-frontal diameter. Free bending and forward displacement of the occipital plate reduces it still further.

#### B. CHANGES IN THE BASE OF THE SKULL CAUSED BY MOLDING AND INCREASED BY COMPRESSION

The study of the composite diagram illustrated in Fig. 7 suggested that elevation of the entire base of the skull behind the sella turcica may occur in molded heads. These changes may be observed in the

base of the skull to advantage in the lateral views shown in Figs. 8 and 9. In the unmolded head (Fig. 9), the base of the skull is flat and the sphenopetrous angle is obtuse. In the molded head (Fig. 8), this angle ( $F$ ) is quite acute and the petrous portions of the temporal bone appear to protrude into the posterior-inferior aspect of the cranial cavity. The entire occipital region, including the occipital condyles and the occipital plate is elevated. As a result, the tip of the occipital bone is elevated from one-half to one centimeter above the maxillary-sphenoccipital line (Figs. 8 and 9, line  $ABC$ ). In the postnatal period, the tip of the occipital bone descends still further and in the adult is at an even lower level to the maxillary-spheno-occipital line.

Elevation of the occipital plate is associated with elevation of the occipital condyles and the superimposed edges of the petrous portion of the temporal bone. The degree of elevation of these two landmarks at the base of the skull is indicated in the skull outline of these two heads illustrated in Fig. 7. Elevation of the occipital plate is dependent upon bending at the apex of the sphenopetrous angle or within the occipital condyles (see Fig. 6 and Figs. 8 and 9, angle  $F$ ). The sphenopetrous angle is more acute in the molded head.

With molding, changes may occur in the slope of the squamous portion of the temporal bone and the greater wing of the sphenoid bone. It becomes more vertical in molded heads and flares outward in the unmolded forms, indicating that molding decreases the diameter between the crests of these bones in the region of the lateral suture lines (Figs. 10 and 11). This again demonstrates a change in the bones at the base of the skull.

It is difficult to demonstrate basal changes in the average newborn head because in the average case the change is slight and even in marked cases restitution occurs almost immediately. We, therefore, employed a method of towel compression to simulate the squeeze effect of labor and so increase the changes observed and described in the case studies illustrated in Figs. 8 to 11. For safety, the method was first used upon a stillborn infant. We subjected the head to a considerable compression using the method illustrated in Fig. 3. The lateral roentgenograms shown in Figs. 12 and 13 were obtained. It will be observed that there is a marked diminution in the size of the sphenopetrous angle ( $F$ ). There is a slight increase in the length of the sphenovertical diameter ( $AB$ ) as would be expected. It is interesting to observe that the midpetrovertical diameter ( $BC$ ) remains fairly constant indicating that elevation of the condyles has prevented an increase in this diameter as the petrous portions of the temporal bone are elevated also.

When the outline of the vault is traced on copying paper on one film and is compared with the outline of the head in the compression film, it is noted that the entire vault in the compression film has been deflected forward to a definite extent, approximately one-half centimeter (Fig. 14). This diagram also shows that the midpetrovertical diameter

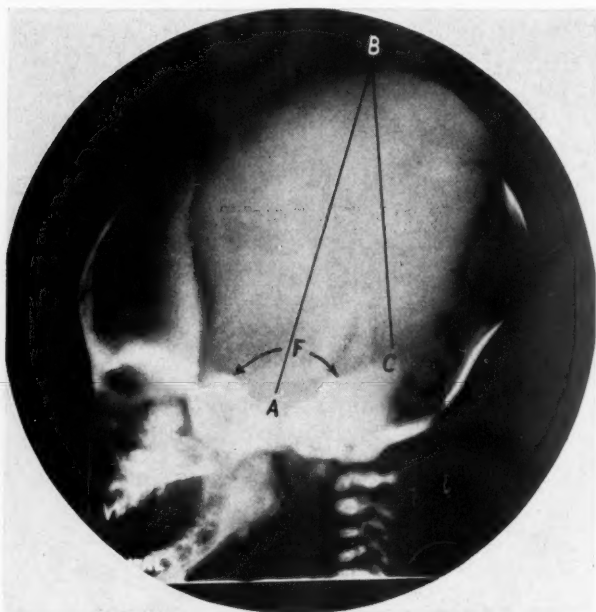


Fig. 12.—Lateral view of a stillborn head without compression. (See also Fig. 13.)

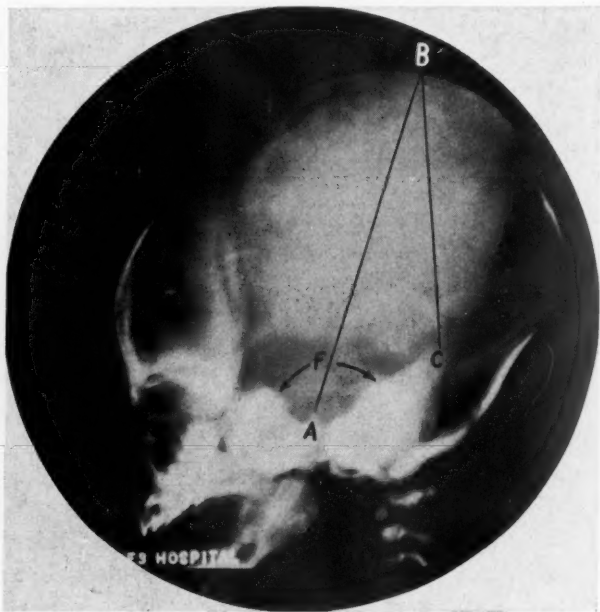


Fig. 13.—Lateral view obtained after compression was applied to case study shown in Fig. 12. Compression causes an increase in the sphenovertebral diameter,  $AB$ , but the midpetrovertical diameter,  $BC$ , remains approximately constant. The sphenopetrous angle,  $F$ , is made more acute by compression.





Fig. 14.—The changes caused by compression in a stillborn infant. The dotted line illustrates the effect of compression. These films were compared by superimposition of the line XX joining the incisor tooth and the tip of the dorsum sellae (case study of Figs. 12 and 13). The degree of elevation of the occipital region in the compression case (dotted outline) as compared to the resting lateral (solid outline) indicates the amount of bending which occurred behind the sella turcica.

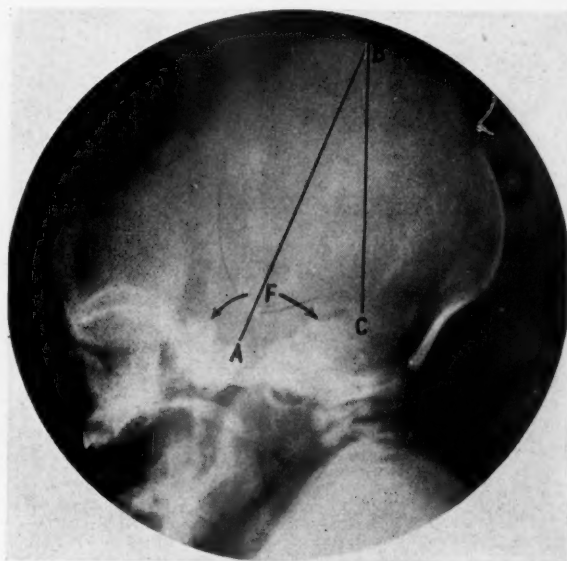


Fig. 15.—Lateral view of the living fetal head obtained one hour after delivery.

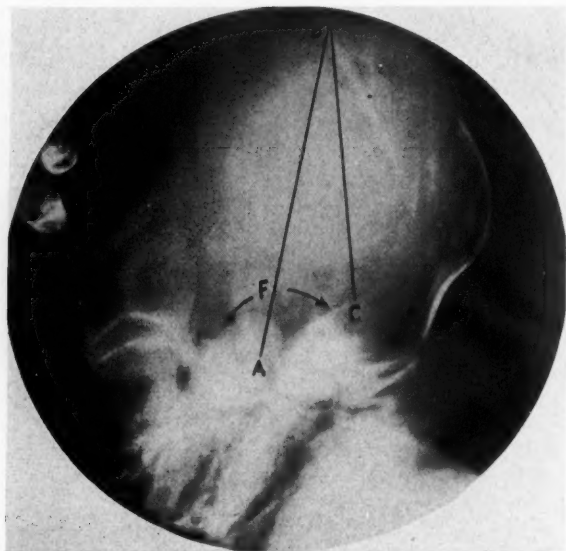


Fig. 16.—Lateral view obtained after compression was applied to case study shown in Fig. 15.

A comparison of these views, Figs. 15 and 16, show changes which are almost identical to those noted in the stillborn case study of Figs. 12 and 13. In Fig. 16 compression has caused an increase in the length of the sphenovertebral diameter  $AB$ , and the sphenopetrous angle,  $F$ , is more acute than in the resting lateral Fig. 15. In both views, the midpetrovertical diameter  $CB$  is fairly constant and has not been affected by compression.

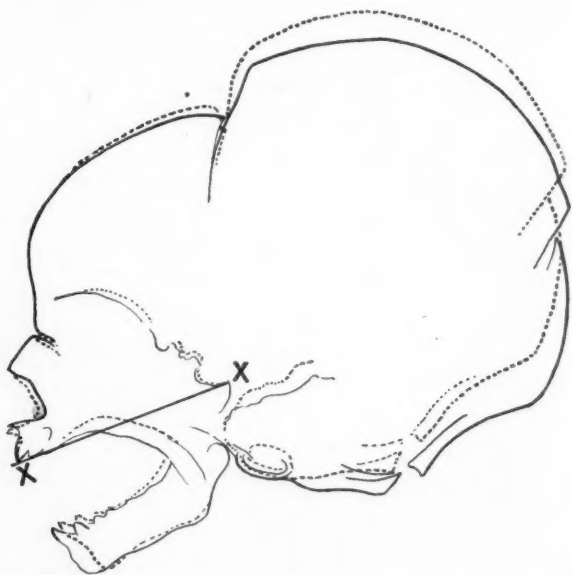


Fig. 17.—Superimposed outlines of the lateral views illustrated in Figs. 15 and 16 show the degree of change in the vault and the skull base caused by compression. Solid outline, resting lateral view. Dotted outline, compression lateral view.

is not increased in the compression outline because the posterior aspects of the base of the skull, i.e., the occipital condyles and the petrous portion of the temporal bones, are elevated by the compression.

It seemed sufficiently important to attempt to produce these findings in the head of a living newborn infant, and after due consideration it seemed that no harm would result from the use of gentle towel compression. As a matter of fact, the mobility at the base of a well-molded fetal head, especially in the negro race, can be demonstrated immediately after birth by hand pressure between forehead and occiput. Quite distinct movement in the bones of the skull base below the lateral suture lines can be appreciated. A compression binder was used on nine living infants. Although the changes described above were noted in all these cases, the use of the towel obscured landmarks necessary for the proper positioning of the head for x-ray examination. Perfect lateral views suitable for illustration purposes were obtained in only two instances and one of these examples is shown in Figs. 15, 16, and 17. These films show compression changes in the skull base and cranial vault which are identical with the changes observed in the stillborn case study illustrated in Figs. 12, 13, and 14, and in living newborn babies immediately after delivery (Figs. 8 and 10).

It will be observed that the midpetrovertical diameter is not increased by towel compression in a living child quite similar to the situation created by compression in the stillborn infant (Figs. 12, 13, and 14). This is an important observation. It suggests that in average molding the tentorium which is attached to the petrous portion of the temporal bone will not show increased tension. It has always been assumed that, in molding, considerable tension is placed on the tentorium cerebelli by elevation of the vault of the skull. It would seem that increased tension in the tentorium may not occur in the average case because the petrous portion of the temporal bone elevates and so prevents tension in spite of the fact that the sphenovertical diameter is increased in length.

From the study of all these examples, the nature of molding seems to be as follows:

1. There is an increase in the sphenovertical and to a lesser extent in the maxillary-vertical diameters.
2. The sphenopetrous angle is made more acute through bending at the suture line existing between the sphenoid and basiocciput.
3. The occipital condyles are elevated.
4. The petrous portions of the temporal bone are elevated.
5. The occipital plate is elevated.
6. The vault of the skull, i.e., the occipital and parietal regions, is displaced forward.
7. The midpetrovertical diameter is constant because, with compression, the base of the skull behind the sella turcica is elevated and thereby maintains a constant length to this diameter.

B. THE MECHANISM OF LOCKING AT THE CORONAL AND LAMBDOIDAL SUTURES

Examination of the suture lines and the hinge action of the occipital plate in stillborn infants after the scalp is reflected shows several interesting facts. When pressure is applied to the parietal bones laterally, the median sagittal suture closes and all transverse diameters are slightly reduced in size. The diameter between the anterior-inferior borders of the parietal bones at the anterior lateral fontanel (the anterior-inferior biparietal diameter, see Fig. 5) is narrower than the bifrontal diameter.



Fig. 18.—Locking mechanism as demonstrated on the stillborn infant after scalp has been reflected. When pressure is exerted between the parietal bones a form of locking occurs at the junction of the middle and lower third of the coronal suture (see arrow).

The posterior edge of the frontal bone along the coronal suture, therefore, crosses the anterior edge of the parietal bones on either side as these lines converge toward the anterior fontanel (see Fig. 18). As a result, an effective locking occurs at the junction of the lower and middle third of the coronal suture which limits to a great extent any forward displacement of the parietal bones. This observation may explain the fairly constant position of the posterior-superior angle of the frontal bones for both the molded and unmolded heads as revealed by Fig. 7B. For this reason, it is unusual to find any overlapping along the coronal suture except to a very slight extent at the posterior-superior angle of the frontal bones. The apparent overlapping of the parietal and frontal bones is not true overlapping but is brought about

by the elevation of the parietal bones which changes the direction of the anterior fontanel from a horizontal to a more vertical plane. This is really pseudo overlapping.

A similar but less effective mechanism of locking occurs at the lambdoidal suture (Fig. 19). In a newborn infant, the occipital plate has a considerable range of movement forward and backward on the occipital hinge which results in overlapping, as the occipital plate is depressed under the posterior free edge of the parietal bones. As soon as pressure



Fig. 19.—Locking mechanism as demonstrated on the stillborn infant after scalp has been reflected. A similar but less effecting form of locking exists at the lambdoidal suture line (see arrow).

is applied laterally to each parietal bone, this range of motion is considerably restricted and in certain heads overlapping can no longer be demonstrated because locking occurs between the parietal and the occipital bones along the lower third of the lambdoidal suture. In fact, as shown in Fig. 5, the base of the occipital plate is wider than the compressed posterior-inferior-biparietal diameter and the occipital plate actually overrides the parietal bones for a short distance just above the posterior lateral fontanel. The free edge of the occipital bone crosses the free edge of the parietal at this point and a form of locking occurs (Fig. 19). As a matter of fact, the significance of locking along these suture lines was not fully appreciated until a cephalic



application of forceps was made to a stillborn infant after the scalp had been reflected. As soon as slight pressure was exerted by the forceps in the biparietal diameter, effective splinting of the cranial vault occurred and as pressure was increased, the effectiveness of the locking mechanism at the coronal and lambdoidal sutures became more apparent. With the head thus held, the vault as a whole becomes relatively immobile and considerable external pressure is required to depress any single bone. During labor, between contractions, the occipital plate may underride the parietal bones at the lambdoidal suture lines, and in front, the frontal bones may also slide under the parietal bones. However, with a contraction, the constriction forces which reduce the biparietal diameter bring about this mechanism of locking at the coronal and lambdoidal suture lines which prevents and may even reduce overlapping and so protects the cranial contents from injury. It is evident that after this locking mechanism has occurred no further molding of the vault by overlap of bones can take place. Further molding with diminution of the occipitofrontal and increase of the sphenovertical diameters does, however, take place as the labor goes on and the compression forces continue to act. The explanation of this is to be found in a study of the base of the skull. It has hitherto been believed and taught that the base of the skull was rigid and underwent no molding. Studies of our roentgenograms disprove this.

#### CONCLUSIONS

This investigation draws attention to changes in the base of the skull, a region hitherto considered unaffected by the stress of labor. To demonstrate and magnify these changes, a compression binder was used to simulate the squeeze of labor. Certain cephalic diameters have been described which are directly affected by these changes. During extreme molding the midpetrovertical diameter remains constant. We believe this observation is important since it would infer that it acts in a protective manner to avoid tension on the tentorium cerebelli. This investigation, however, is concerned with a discussion of skull changes rather than with the influence of these changes upon intracranial mechanics. The concept of the mechanism of molding brought out by this investigation is that there is locking of the frontal and parietal bones at the coronal suture, and to a lesser extent, of the occipital and parietal bones at the lambdoidal suture. This mechanism of locking allows bending and displacement in the vault because there are compensating changes in the base. Basal changes consist of elevation of the occipital region with bending at the sphenopetrous angle.

Although this study is a part of the larger problem regarding the question of disproportion between the head and the pelvis, no constructive ideas regarding the estimation of head size have been developed. We believe the changes observed are important enough to report in the hope that the observations may be confirmed by other workers.

The author wishes to express his appreciation to Dr. Ross Golden and Dr. Caffey of the Department of Radiology of Presbyterian Hospital and Babies' Hospital for their interest in this study. The interest and technical assistance of Miss Piper and Mr. Watts are also deeply appreciated. The author is indebted to Miss Powers and Mrs. Fries, supervisors of the Delivery Room and the Nurseries of the Sloane Hospital for Women for their cooperation in these studies.

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## DISCUSSION

DR. SAMUEL A. COSGROVE, JERSEY CITY, N. J.—It seems to me that the new concept of molding which Dr. Moloy has presented consists essentially in his statement that the bones of the base of the skull partake in a change in relationships, due to molding, in addition to the changes of the calvarium, which have long been recognized. He has presented certain evidence in support of this concept.

I hope as he does that his observations will be confirmed by other workers, for I am afraid that the evidence presented, and that is all which we have at this time to go on, might fail to be strongly convincing. For instance, in the two films comprising Figs. 1 and 2, the sphenopetrous angle is just about the same immediately after birth and eleven days later. Had much distortion originally existed, is it not reasonable to suppose that it would have changed in eleven days, as that of the calvarium so plainly has?

In Figs. 8 and 9 are pictures of *different* heads. Contours of the same parts may well vary in different individuals without relation to the effects of compression. In Figs. 1 and 2, tracings of the contours of the bones themselves do not coincide in the two pictures. This suggests that slight changes in the angle at which the two films were taken may also account for the apparent difference in relationship. In Figs. 12 and 13, tracings of the contours of the bones in the two films almost coincide, the difference being too small to be significant. In Figs. 15 and 16, the apparent difference is obtained by superimposing an arbitrary artificial line in the two films. When the *contours of the bones* are superimposed, the difference in relation is much less apparent.

I have, however, no desire to be hypercritical, for I think his work has most important clinical implications. If true, it means: (1) that such basilar molding occurs only in relatively high degrees of disproportion; (2) that it is the *last* part of total molding to take place; (3) that it is the slowest and most difficult part of molding; (4) that engagement cannot be complete before it has been accomplished; (5) that this takes lots and lots of time; (6) that therefore arbitrary limitation of time for the duration of the second stage are invalid; (7) that the accomplishment of complete molding, and not the complete dilatation of the cervix, becomes the *most important criterion* for the proper exhibition of artificial interference.

If there can be universal realization of these implications of Dr. Moloy's work, and if thereby current premature and pernicious interference can be reduced, then his contribution constitutes a service which the Society may well hail as of the highest value.

DR. LEROY A. CALKINS, KANSAS CITY, MO.—Like Dr. Cosgrove, I feel that this is possibly a portentous move in the direction of a truer knowledge of clinical obstetrics. Perhaps it does not make so much difference which one of the 16 types of pelves we are dealing with as it does how the passenger fits into and goes through that pelvis.

Some 20 years ago I made an attempt to solve this particular problem of head molding, at the suggestion of Dr. Litzenberg. I tried to answer the age-old question of whether birth molding is a change in shape only or is, in part, a change in size? I attempted this on the basis of measurements by water displacement, comparing the well-known differences between dead born infants and liveborn infants, as well as the differences between those infants delivered by cesarean section and those delivered after a rather long and difficult labor. My attempts indicated roughly that there were no changes in size, but the measurements were subject to such inaccuracies that I did not publish the observations. I am very glad therefore to see this beginning made by Dr. Moloy to prove that birth molding does not involve any change in size but only a change in shape.

Dr. Moloy refers rather late in his paper to the protection the infant has against overcompression by forceps application, due to "locking" at both the coronal and lambdoid sutures. That is all very well if the forceps are correctly applied and there is no asynclitism. I think, however, a warning should be sounded that if the forceps happen to be oblique this "locking" might not be so favorable.

DR. BENJAMIN P. WATSON, NEW YORK, N. Y.—What interested me most in this work was the demonstration that molding is not limited to the vertex but that the base of the skull takes part in it. We have always taught that the base of the skull is the fixed portion and that all molding occurs in the vertex. But if you take a stillborn baby and compress the head in the occipitofrontal diameter you will feel very definitely that angulation occurs at the base of the skull. It is just like a hinge. That to me is a totally new concept and I think is one of the most important things brought out in this paper.

DR. FRED L. ADAIR, CHICAGO, ILL.—Dr. Moloy's contribution is important, both for a better understanding of the physiology of labor so far as the fetus is concerned, and also with reference to the fetal pathology which results from the abnormal types of labor. We should recognize, however, that we may have compression of the head without molding; although we never have molding without compression. The child's head is not a perfect sphere nor the birth canal a perfect cylinder, which makes considerable difference in the causation of head injuries.

DR. MOLOY (closing).—I wish once more to emphasize that in any routine series it is now rare to find extreme molding resulting from a delivery during which a definite degree of disproportion was overcome by flexion and molding. It is in this type of case that the vault and especially the base of the skull show the changes described in this report. At the present time, cesarean section is employed frequently in borderline cases of disproportion as in the case study illustrated in Figs. 15 and 16. Here the degree of disproportion was great enough to consider this method of delivery several times during the long labor. This case was the one which showed marked changes in the base of the skull when compression was used.

## CLASSIFICATION OF THE OBSTETRIC PELVIS BASED ON SIZE, MENSURATION, AND MORPHOLOGY\*

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SIZE has been the criterion most generally employed by obstetricians for dealing with the obstetric pelvis regardless of the underlying etiology, pathology, or morphology. Mensuration, through internal and external pelvimetry, has supplied the means for classification. The present clinical results have been attained on this basis.

The roentgen ray techniques have provided information as to morphology and have made x-ray pelvimetry possible for the determination of size and have provided a knowledge of labor mechanisms. The close interrelationship of all of them has been established. Further advance and greater precision in obstetric practice through the utilization of this knowledge are to be expected. It is evident that the first step in this direction is a provision for morphology in pelvic classification. Two morphologic classifications have been recently proposed and dissimilar methods of radiographic study are employed by their advocates. Morphology is determined in different ways. It is the purpose of this communication to consider these classifications, as well as the methods of diagnosis, and to outline a method of approach which combines the best features of each.

### HISTORICAL

Classifications of the obstetric pelvis have been under discussion for the past 241 years. Van Deventer is credited with the first classification in 1701. Pelvic mensuration was employed by Baudelocque, Smellie, Michaelis, and Litzmann. Anatomists and anthropologists have long employed morphology as a basis of classification as illustrated by the work of Stein, Weber, and Turner. Thereafter, etiologic and pathologic classifications were advanced by Schauta, Tarnier-Budin and Breus and Kolisko. In this country, Williams in 1903, provided a classification based on a combination of the earlier concepts. He was supported in his views by DeLee. In the recently proposed morphologic classifications, Thoms advocates the study of form by means of mensuration and the pelviscope, whereas Caldwell and Moloy employ direct observation of an undistorted image in the precision stereoscope. Very recently (1941), Stander has proposed a combined etiologic and morphologic classification. In the main, discussion has revolved around seven pelvic types, as summarized in Table I.

\*Read, by invitation, at the Sixty-Seventh Annual Meeting of the American Gynecological Society, Skytop Lodge, Pa., June 15 to 17, 1942.

†Dr. Steele died June 18, 1942.





The etiologic classifications, including that of Williams, divide all pelvises into normal and contracted forms. Eliminating the rare pathologic forms and comparing the remainder of the pelvises, which constitute about 99 per cent of all pelvises, one finds that about 85 per cent are normal and adequate, and 15 per cent contracted. In either group, classification according to pelvic morphology can be carried out as indicated in Fig. 1. The term growth variants long employed by anthropologists is all inclusive as to the etiologic factors, namely, growth hormones, sex hormones, nutrition, retardation, mechanical stresses, etc. The etiologic role of these has not been clearly established, but they probably influence size and morphology.

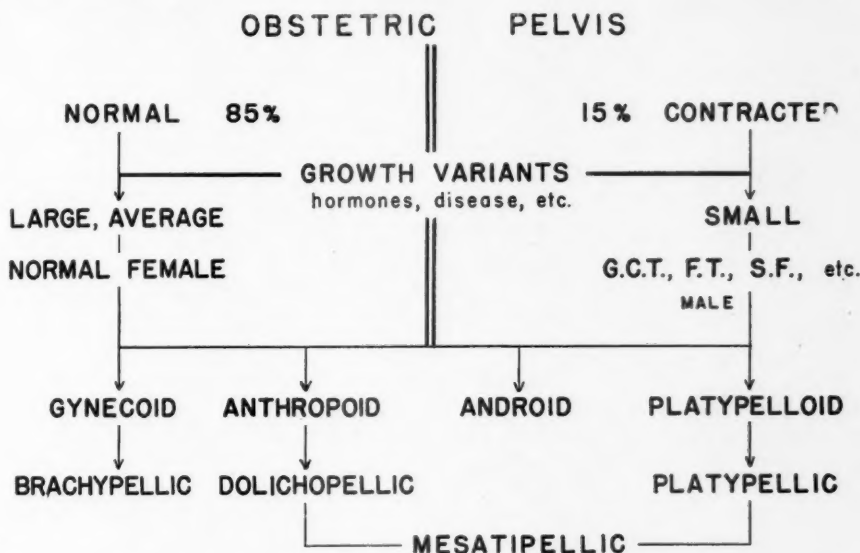


Fig. 1.—Showing how growth variants influence size and morphology of the obstetric pelvis.

#### RECENTLY PROPOSED MORPHOLOGIC CLASSIFICATIONS

Thoms has proposed a classification based upon morphology of the pelvic brim. A study of distorted roentgen ray images has provided the background for his classification. Thoms describes only four types. As a specific criterion to determine morphology, he uses a simple relationship of the anteroposterior and transverse diameters and has regarded this as an adequate index of form, which is essentially the method proposed by Turner in 1866. Omission of the android type of inlet is especially noteworthy.

The relationship of the anteroposterior diameter to the transverse diameter of the inlet is not always a true index of form, as shown in Fig. 2. The anteroposterior and transverse diameters are the same in all three figures. It is manifest that this index fails to show (1) shortening in the posterior sagittal diameter; (2) narrowing in the forepelvis; which serve to distinguish the well-known pelvic types, namely, male and female; and (3) asymmetry. Calculation of pelvic capacity on the basis of these diameters is also inaccurate, as indicated in Fig. 3.

Thoms has popularized the centimeter grid technique for securing an image of, and measuring the superior strait. The plane of the anteroposterior diameter of the inlet has been obtained by means of external anatomic landmarks, and the grid has been exposed in an inclined posi-



Fig. 2.—Relationship of the A-P diameter to the transverse is not a true index of form.

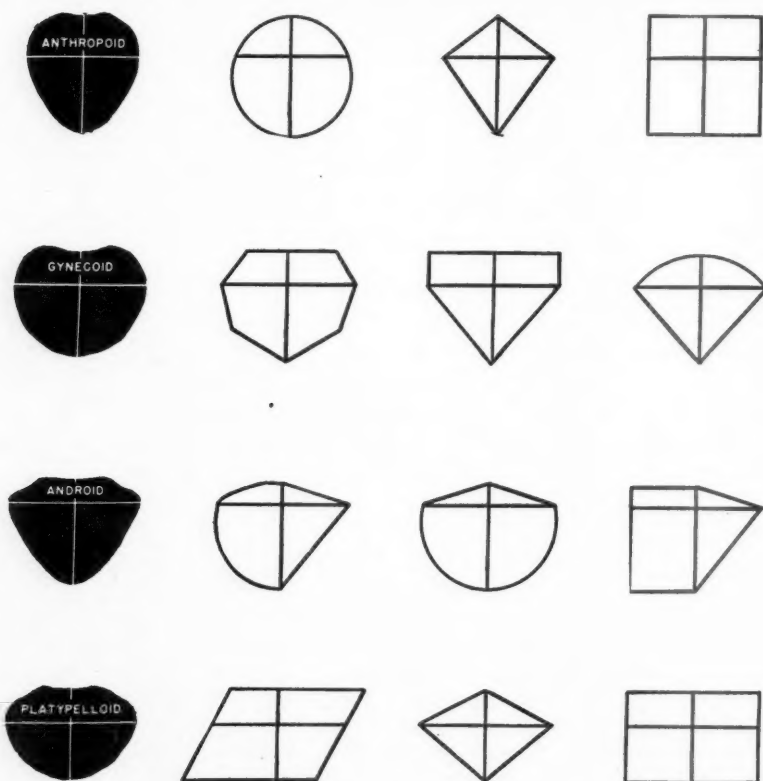


Fig. 3.—Anteroposterior and transverse diameters are not a true index of morphology, nor of volumetric capacity, at the pelvic brim.

tion. This has resulted in unequal distortion of the anteroposterior and transverse diameters of the inlet because the transverse diameter is often as much as 2 cm. below the anteroposterior diameter, as has also been pointed out by Snow. In a study of dried pelves, employing the original

technique of Thoms, an error slightly in excess of a centimeter was found in 3 out of 4 pelves in the transverse diameter, as shown in Table II. This error has been eliminated in Thoms' newer technique in which the centimeter grid is placed parallel to the film and in the plane of the ileopectineal lines.

A comparison of data published by Thoms shows a difference of 0.5 cm. between the anteroposterior and transverse diameters in the predominant or average female pelvis, and is very much below the difference of 2.0-2.5 cm. recorded by other authors, as shown in Table III. The potential error in technique demonstrated experimentally may explain the variations in measurements of the predominant pelvic type reported by Thoms. Strict adherence to the sole mensurational criterion employed also probably explains the failure to recognize the android or male type of inlet recognized by most anthropologists, anatomists, and some obstetricians.

TABLE II. TRANSVERSE DIAMETER IS DISTORTED WHEN THE CENTIMETER GRID LIES IN THE PLANE OF THE C.V. DIAMETER AND PARALLEL TO X-RAY FILM

DRIED Pelves		A		B		C		D	
DIAMETERS		C.V.	TRANS.	C.V.	TRANS.	C.V.	TRANS.	C.V.	TRANS.
Cm.	Actual	11.0	13.6	10.7	13.2	10.8	14.0	11.0	12.9
	Grid	11.0	13.0	10.7	12.0	10.8	12.8	11.0	11.8
Difference		0.0	0.6	0.0	1.2	0.0	1.2	0.0	1.1

TABLE III. COMPARISON OF ANTEROPOSTERIOR AND TRANSVERSE INLET DIAMETERS OF THE AVERAGE FEMALE PELVIS

DIAMETER (CM.)	STANDER DE LEE	JARCHO	TODD	CALD- WELL- MOLOY	STEELE	THOMS
Anteroposterior	11.0	11.0	10.8	11.2	11.0	11.5-12.25
Transverse	13.5	13.5	13.7	13.2	13.0	12.0-12.75
Difference	2.5	2.5	2.9	2.0	2.0	0.5
Predominant pelvic type	←female→		←gynecoid→			mesatipellic

The use of a centimeter scale in the lateral film provides accurate measurements of anteroposterior diameters in the sagittal plane of the pelvis and is employed by ourselves (Fig. 4) as well as by Thoms and Caldwell and Moloy.

Caldwell and Moloy have proposed a morphologic classification in which is described four parent forms based on a study of dried pelves. They divide the pelvic inlet into an anterior and posterior segment and provide for combinations of these segments so that 14 forms result. In their total material these forms are divided equally into pure and mixed types, and this division has been observed in the pelves studied at Cornell. They employed the precision stereoscope primarily for a study of morphology and secondarily for mensuration. The stereoscopic technique has been approved by the Society of American Roentgenologists and has been considered extremely accurate. Difficulty has been experienced by many when using the stereoscope for mensuration.

Caldwell and Moloy have insisted on provision in their classification for the pelvis as a whole, including the brim, midpelvis, and outlet. They

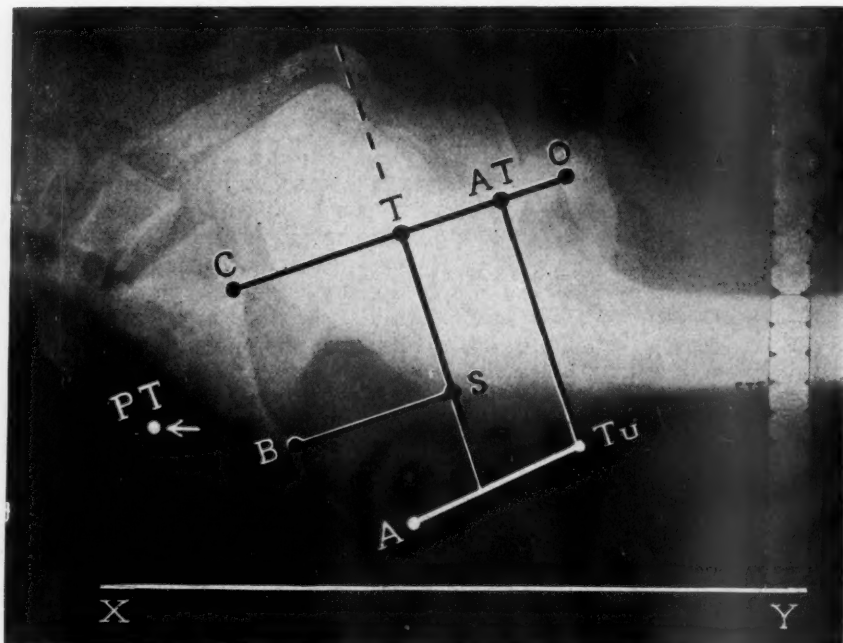


Fig. 4.—Lateral film. Base line X-Y is drawn perpendicular to the centimeter rule at the lower tip. Anteroposterior diameter of the inlet C-O is drawn in the plane of the ileopectineal lines projected on the sacrum and symphysis. T-S is a perpendicular to the inlet drawn through the bases of the ischial spines; and provides the plane of the transverse diameter of the inlet. If continued upward, it passes through the iliac crests. A coronal plane in the transverse diameter divides the entire pelvis into anterior and posterior segments. C-T and T-O are the posterior and anterior sagittal diameters. Points T, AT, PT, S and Tu, mark the vertical heights of their respective transverse diameters (shown in Fig. 5) from base line X-Y.

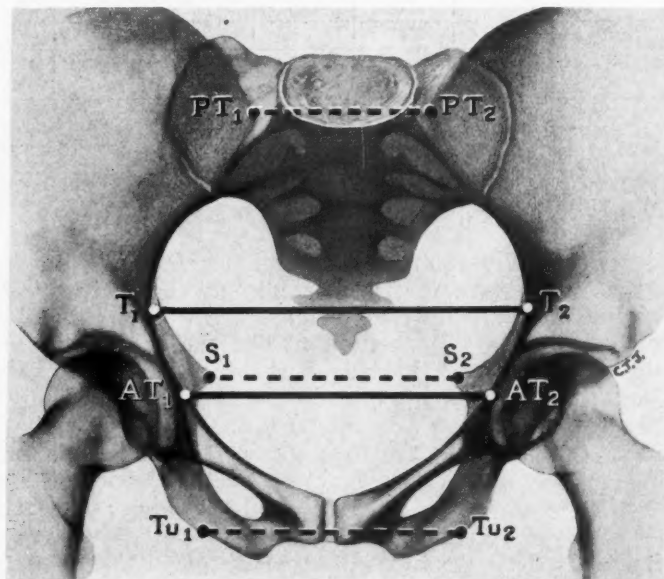


Fig. 5.—Frontal film. Showing the transverse ( $T_1$ - $T_2$ ) anterior and posterior transverse ( $AT_1$ - $AT_2$ ,  $PT_1$ - $PT_2$ ) diameters, interspinous ( $S_1$ - $S_2$ ), and intertuberos ( $Tu_1$ - $Tu_2$ ) diameters. These can be measured on distorted scales corresponding to their vertical heights, T, AT, PT, S, and Tu, obtained from the lateral film (Fig. 4).

provide a long list of terms referable to the sacrosciatic notch, sacral curvature, lateral bore, sidewalls, interspinous and intertuberous diameters. Thoms is in agreement on the necessity of considering the pelvis as a whole. From the obstetric viewpoint, it is apparent that a knowledge of the architecture of the canal and outlet is as necessary as that of the brim. Although the method proposed appears cumbersome, at present there is no other way of dealing with this situation.

#### COMBINED ISOMETRIC AND STEREOSCOPIC TECHNIQUE

Experience with the isometric scale principle of Thoms and the stereoscopic technique of Moloy has shown advantages and disadvantages as indicated above. Certain desirable principles of both have been retained in a combined technique described elsewhere. Identical positioning of the patient has facilitated joint workup of the lateral and frontal films. Anteroposterior and sagittal diameters as well as the vertical heights of transverse diameters can be obtained from the lateral film, as shown in Fig. 4. The latter are of value in measuring transverse diameters in the frontal films, shown in Fig. 5, on a set of distorted scales. Morphology is studied in the precision stereoscope of Moloy as shown in Figs. 8 and 9.

The anterior transverse diameter recently described by Steele and Javert and the posterior transverse diameter described below are of particular value in detecting the android type of pelvis. This has been substantiated by a study of dried pelves as well as a large number of patients and their roentgenographic films. Values for this diameter are given in Table IV.

#### POSTERIOR TRANSVERSE DIAMETER

The iliac crests just above the posterior superior spines have depressions or dimples contributing to the formation of the rhomboid of Michaelis. These points represent the projection posteriorly of the linear terminalis of Breus and Kolisko, drawn in the planes of the ileopectineal lines on either side of the pelvic inlet. These lines also traverse the iliac tuberosities.

TABLE IV. AVERAGE MEASUREMENTS OF THE ANTERIOR AND POSTERIOR TRANSVERSE DIAMETERS IN DRIED PELVES

MORPHOLOGY	POSTERIOR SEGMENT		ANTERIOR SEGMENT	
	NO. OF PELVES	POST. TRANS. DIAMETER CM.	NO. OF PELVES	ANT. TRANS. DIAMETER CM.
Gynecoid	34	7.1	34	11.6
Android	23	5.3	23	9.9
Anthropoid	8	7.4	6	10.3
Platypelloid	4	6.8	6	12.4
Total	69		69	

The posterior transverse diameter (or posterior cristal or posterior tuberal), shown in Fig. 5, can be measured on the frontal film between the shadows of the iliac tuberosities. The vertical height is obtained from the lateral film at PT in the horizontal plane of the junction of the second



and third sacral vertebrae, as indicated in Fig. 4. It can be measured clinically with the small Williams' pelvimeter by selecting the medial edges of the dimples, or in thin patients, the actual inner margins of the iliac crests at the proper points. X-ray measurement is ordinarily about a centimeter less than the clinical measurement.

This diameter is greater in the female pelvis than in the male as has been pointed out by Jarcho and confirmed by a study of 69 dried pelves in the Cornell University collection. In 34 dried gynecoid pelves, an average measurement of 7.1 cm. was obtained and in 23 dried android pelves, the average was 5.3 cm. as shown in Table IV, a difference of nearly 2 cm. The posterior transverse diameter provides an excellent opportunity for the recognition of the android posterior segment.

#### PROPOSED METHOD OF CLASSIFICATION OF THE PELVIC INLET

The incorporation of the isometric and stereoscopic principles of Thoms and Caldwell and Moloy into a combined technique was prompted in part by the hope that the nomenclature of their classifications could also be combined. The terms, "dolichopellic" and "anthropoid," and "platypellic" and "platypelloid," refer to the anteroposterior ellipse and transverse ellipse respectively as shown in Table I. The terms are synonymous and may be used interchangeably. However, this does not hold for the large intermediate group of pelves, namely, the "mesatipellic" and "gynecoid," and the "brachypellic" and "android" forms; which constitute about three-fourths of the total number, as shown in Table V. These two groups are not isometric judging from the available descriptions. As a matter of fact, as indicated in Table I, the mesatipellic pelvis of Thoms has been placed with the round or female types of other authors, whereas, the brachypellic pelvis is situated with the oval pelves. It has been long recognized that the female pelvis was oval, and Caldwell and Moloy (1942) have agreed to the inclusion of their gynecoid type with this group, so that it now appears that the gynecoid and brachypellic pelves are similar. The mesatipellic is probably a mixed gynecoid with anthropoid. Therefore, care must be utilized when combining both classifications.

TABLE V. INCIDENCE OF PELVIC TYPES

PELVIC TYPE	TODD		CALDWELL-MOLOY		STEELE		THOMS	
Gynecoid	41.4		50.0		56.3		—	
Mesatipellic	—		—		—		45.9	
Brachypellic	—		—		—		32.2	
Android	32.5		22.5		19.6		—	
Total		73.9		73.0		75.9		78.1
Anthropoid dolichopellic	23.5		22.7		17.0		18.6	
Platypelloid platypellic	2.6		4.3		7.1		3.3	
Total		26.1		27.0		24.1		21.9
Grand Total	100.0%		100.0%		100.0%		100.0%	

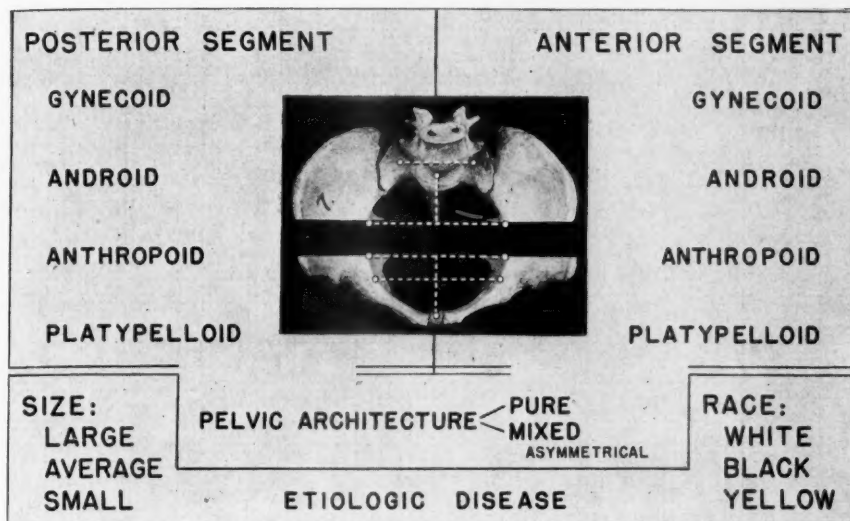


Fig. 6.—Classification of the obstetric pelvis based on mensuration and morphology (clinically and/or radiographically).

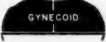




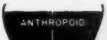


	POSTERIOR SEGMENT				ANTERIOR SEGMENT			C. O.
	MORPHOLOGY	POSTERIOR		TRANS.	MORPHOLOGY	ANTERIOR		
		TRANS.	SAG.			TRANS.	SAG.	
GYNECOID								
pure		7.5	5.0	13.2		11.3	6.2	11.2
mixed		7.1	5.5	12.8		10.8	6.4	11.9
ANDROID								
pure		5.9	3.7	12.9		10.2	6.5	10.2
mixed		6.0	3.9	13.1		10.9	7.1	11.0
ANTHROPOID								
pure		7.5	6.0	12.2		10.2	6.6	12.6
mixed		7.2	6.1	12.4		10.9	6.2	12.3
PLATYPELLOID								
pure		8.2	4.8	14.3		12.4	5.8	10.6
mixed		8.0	4.7	14.0		11.9	6.1	10.8

Fig. 7.—Criteria for classification of the obstetric pelvis combining mensuration and morphology.

The terminology of Caldwell and Moloy has been employed for the following reasons: (1) lack of agreement on the characteristics of the two predominant pelvic types in either classification; (2) the pelvic inlet has been divided into anterior and posterior segments, and pure and mixed forms can be recognized, for the latter constitutes about 50 per cent of the pelvis; (3) the obstetric value of a given pelvis is increased

or decreased by the character of each segment; (4) the android type of inlet is included; (5) the etymology of "gynecoid," "android," "anthropoid," and "platypelloid," is more distinctive, and less cumbersome, than "mesatipellic," "brachypellic," "dolichopellic," and "platypellic."

This approach is aimed at the determination of size and pelvic form, and therefore, combines size, mensuration, and morphology. Radiographically this can be done with a minimum of error by correcting for distortion and providing for accurate linear measurement of all diameters with the combined isometric scale and stereoscopic technique described above.

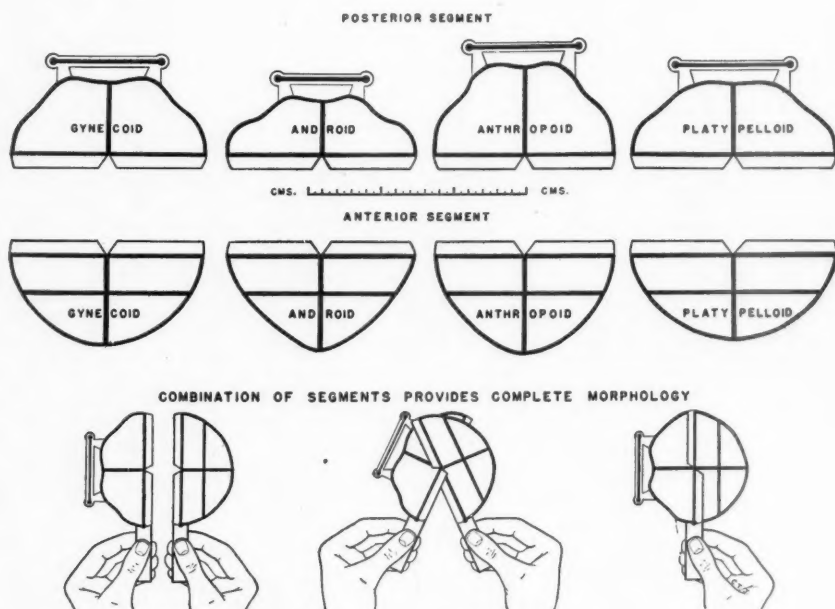


Fig. 8.—Morphology of pelvic inlet is determined according to anterior and posterior segments. These models are for use in the stereoscope as shown in Fig. 9.

It has been recognized that a perpendicular to the anteroposterior diameter of the inlet drawn through the ischial spines passes through the transverse diameter of the inlet. If this perpendicular is projected upward, it also passes through the iliac crests as shown in Fig. 4. Cutting the pelvis in the coronal plane of the transverse diameter divides the entire pelvis into anterior and posterior segments, as shown in Fig. 6. Each segment can be regarded as having gynecoid, android, anthropoid, and platypelloid characteristics. Accordingly, pure and mixed forms can be recognized. Further differentiation of the pelvis as to size, namely; large, average, and small, is included. Etiologic disease can be added in the rare instances as encountered (less than 1 per cent), although a study

of such pelvis radiographically has shown that they can be usually classified morphologically.

The criteria for classification using morphology and mensuration of the anterior and posterior segments, based on 1,000 cases, are shown in Fig. 7. In the posterior segment, the morphologic conformation of the superior strait as well as the transverse, posterior transverse, and posterior sagittal diameters are evaluated. With regard to the anterior segment; morphology, and the transverse, anterior transverse and anterior sagittal diameters, are considered. Mensuration is practiced in the stereoscope and on the distorted isometric scales. Ordinarily the measurements vary only 2 mm. with either technique. This approach for consideration of the anterior and posterior segments, according to four parent types, is shown in Fig. 8. These outlines were derived from composite tracings of the inlet made from images in the stereoscope of the four parent pelvic types on glass. The latter was placed in the plane ordinarily employed



Fig. 9.—Precision stereoscope is used for classification of the inlet using models of anterior and posterior segments shown in Fig. 7, and also for mensuration.

for mensuration. The diagrams were altered slightly to conform to the average measurements for pure types given in Fig. 7. Individual diagnosis of each segment is obtained from undistorted images in the precision stereoscope as shown in Fig. 9. Combination of anterior and posterior segments provides for the recognition of pure and mixed forms at the pelvic brim. The morphology in 1,000 pelvis was determined according to segments in the above manner and the incidences are given in Table VI.

#### NORMAL AND CONTRACTED PELVES

The greatest value of mensuration, whether performed clinically or by x-ray, is the determination of pelvic size. Yet, as shown in Fig. 7, mensurational values have some relationship to morphology. Pelvis can be divided into normal and contracted forms on the basis of size, mensuration and morphology. Clinically, the incidence of normal pelvis

is 85 per cent, leaving 15 per cent as contracted, as shown in Fig. 1. The criterion for this division is a diagonal conjugate of 11.5 centimeters.

TABLE VI. INCIDENCE OF MORPHOLOGY AT THE PELVIC INLET ACCORDING TO SEGMENTS IN 1,000 CASES

PELVIC TYPE	POSTERIOR SEGMENT		ANTERIOR SEGMENT	
	NUMBER	PER CENT	NUMBER	PER CENT
Gynecoid	563	56.3	575	57.5
Android	196	19.6	138	13.8
Anthropoid	170	17.0	176	17.6
Platypelloid	71	7.1	111	11.1
Total	1,000	100.0	1,000	100.0

Using a similar standard for comparison, namely, an obstetrical conjugate of 10.5 cm.,\* the incidence of normal and contracted pelvis was found to be 70 per cent and 30 per cent, respectively, as shown in Table VII. In other words, x-ray pelvimetry virtually doubled the incidence of contracted forms! On this basis, the gynecoid and anthropoid varieties, constitute 567 of the 700 normal pelvis, or 81 per cent, whereas, the platypelloid and android types account for 134 of the 300 contracted group, or 44.1 per cent. Small gynecoid pelvis are also frequent. A clinicoradiographic study of 300 pelvis has also indicated that an unusually large percentage of contracted pelvis were either android or platypelloid in character, showing that size may also be useful clinically in predicted pelvic morphology. Studies now in progress indicate that this can be accomplished with a considerable degree of accuracy.

However, the combined isometric scale and stereoscopic technique illustrated in Figs. 4, 5, 8, and 9, provides an excellent opportunity for the practice of x-ray pelvimetry for the accurate determination of pelvic size, and for direct visual study of morphology, both of which are essential for the proper classification of the obstetric pelvis.

#### CONCLUSIONS

1. Size and morphology constitute the most practical basis for classification of the obstetric pelvis.
2. Mensuration, utilizing x-ray pelvimetry, serves primarily to determine size. Size is an index of morphology in an unusually large percentage of contracted pelvis, which are often of the android, platypelloid, or small gynecoid types.
3. X-ray pelvimetry of 1,000 cases has demonstrated that 30 per cent were contracted in contradistinction to an incidence of 15 per cent detected by clinical pelvimetry.
4. Morphology can be most easily and most accurately determined by the direct study of form using the precision stereoscope.

\*This is 1 centimeter less than the average measurement of 11.5 cm. obtained for the obstetric conjugate in 1,000 cases studied radiographically.



5. All forms encountered must be provided for in a formal classification. The terminology of Caldwell and Moloy has been employed because it provides for the recognition of pure and mixed types. The terms have correct etymology. Care must be utilized when combining their nomen-

TABLE VII. PERCENTAGE INCIDENCE OF NORMAL\* AND CONTRACTED† Pelves ACCORDING TO MORPHOLOGY IN 1,000 CASES

MORPHOLOGY	NORMAL		CONTRACTED		TOTAL	
	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER	PER CENT
Gynecoid	409	72.6	154	27.4	563	56.3
Android	107	54.5	89	45.5	196	19.6
Anthropoid	158	92.9	12	7.1	170	17.0
Platypelloid	26	36.6	45	63.4	71	7.1
Total	700	70.0	300	30.0	1,000	100.0

\*CO. = 10.5 cm. and over.

†CO. = under 10.5 cm.

elature with that of Thoms. While the terms "dolichopellic" and "anthropoid," "platypellic," and "platypelloid" are interchangeable, there is still some question regarding the admissibility of doing so with the "brachypellic" and "gynecoid," and the "mesatipellic" and "android" types.

6. The problem presented by the irreducible multiplicity of form can be lessened by individual classification of the anterior and posterior segments of the inlet.

7. The combined isometric and stereoscopic technique provides an excellent opportunity for the determination of size and for the study of morphology of the obstetric pelvis.

8. Clinical pelvimetry, using revised concepts, has shown considerable promise and is being investigated further. In this, the posterior transverse diameter should prove of assistance in detecting the android posterior segment.

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#### DISCUSSION

DR. BENJAMIN P. WATSON, NEW YORK, N. Y.—We as obstetricians are under a great debt of gratitude to men such as Thoms, Caldwell and Moloy, and now Steele, who in the past ten or fifteen years have been directing our attention to the variations in the morphology of the female pelvis and their effects upon the mechanism of labor.

There is, of course, nothing new under the sun. These variations were known to the older anatomists and to some of the older obstetricians, such as Berry Hart; but their frequency, their methods of recognition, and their clinical importance were not stressed until our attention was re-directed to them by the investigators mentioned.

The broad classification of Caldwell and Moloy, which places female pelvis in four main types: gynecoid, anthropoid, android, and platypelloid, has received practically universal acceptance, at any rate in English speaking schools of obstetrics. This classification is based upon the shape of the pelvic brim, the relative lengths of its anteroposterior and transverse diameters, and on other morphologic features in the cavity and outlet.

As always when any subject is more deeply explored, it turns out to be not as simple as at first appeared. Caldwell and Moloy soon found that pelvis were not always of pure type but that mixed forms exist, one part of the pelvic brim or cavity or outlet conforming to one type and another part to another type. So we have the gynecoid-android, the gynecoid-anthropoid, the gynecoid-flat, etc. Dr. Steele in his own studies has followed the classification of Caldwell and Moloy, and in this connection has endeavored to simplify it and to devise means for the easier clinical recognition of the various pure and mixed types. As every obstetrician has not access to the precision stereoscope, and even if he had may not be trained in its use, he has sought for simple clinical methods of diagnosis.

In this connection Dr. Steele has brought out several very interesting points:

1. That clinical measurement of the anteroposterior diameter of the brim will reveal only one-half of the truly contracted pelvis. This seems to be an argument for the more extended use of roentgenologic pelvimetry. When there is a shortened anteroposterior of the brim he has established the fact that the pelvis is more likely to be of the android or platypelloid type than the anthropoid or gynecoid.

2. That a diminution in the transverse of Michaelis' rhomboid is frequently an indication of an android pelvis. This measurement he calls the posterior transverse. This to me was very interesting, for in Scotland we, as students, always had emphasized to us the importance of Michaelis' rhomboid. Any diminution of its transverse diameter was regarded as an indication of a rachitic flat pelvis, of which, as you know, we had a great many there in those days. But probably many of the pelvis we classed as rachitic were really android. Dr. Steele, I am sure, will not take it amiss if I thus hint that his posterior-transverse diameter is nothing new. His interpretation of its variations, however, is new.

Dr. Steele has also stressed the importance of the anterior transverse diameter in relation to the capacity of the forepelvis. A short anterior transverse may entirely nullify a long anteroposterior in an anthropoid pelvis and make delivery impossible.

I feel that it will only be after many more studies of the painstaking character of the work just presented to us that we shall arrive at a simple working classifica-

tion of pelvic types. I do not believe we should worry too much about actual classification now. The important thing is to study each individual case with all the means at our disposal. With an accumulation of such cases we shall ultimately be able to form a better prognosis of labor, using clinical measurement, roentgenologic pelvimetry, and stereoscopic visualization as our guides.

When that classification is possible I feel that more than brim measurements and shape will have to be taken into account. Classification is not an end in itself. It is of value only as a sort of ready reckoner to enable us to arrive easily at an assessment of pelvic shape and size, which in its turn has its practical application in enabling us to form a prognosis of labor and to apply the proper maneuvers at the proper time when difficulty arises.

DR. THADDEUS L. MONTGOMERY, PHILADELPHIA, PA.—My own interest in this subject has to do with the employment of the method in teaching. Through the past years I have had some difficulty in making this method clear and I have turned over in my mind a number of times why such should be the case. I am inclined to believe that the principal difficulty is due to the confusion that has been created by combining the sexual influences with the anthropologic. Why is it more essential to include the masculinizing influence in a morphologic classification than it is to include, for example, the various factors of disease?

Evidently the evolution of the human pelvis is from the anthropoid or dolichopelvic type of inlet through the round pelvis and toward the transversal oval pelvis, as is set forth in Thoms' classification. Why should we call a transversely oval pelvis a gynecoid pelvis, indicating that it is the true female pelvis? The round one may be just as typically feminine as the transversely oval. Furthermore, there is now an effort to include an android pelvis.

I think it would simplify our classification then if we would place the anthropologic considerations second to factors of individual heredity such as the large pelvis, the narrow and the small pelvis. In a third column could be placed the environmental factors, including the masculinizing influences, the endocrine effects, the factors of disease and of trauma, and all of those factors which make for an irregular pelvis.

We do not routinely employ such methods of mensuration as described by Dr. Steele for the accurate determination of pelvic dimensions at the Temple University Hospital. Instead, we resort to the anteroposterior and lateral film of the pelvis at term or during labor to determine in what fashion the presenting part is adapting itself to the pelvic inlet, believing that on the basis of such films and the clinical examination, we are able to formulate the methods of management in frank or relative disproportion.

The rather wide acceptance of the Caldwell-Moloy classification of the pelvis throughout the country has, however, made it necessary in most medical schools to present it as at least one method of pelvic study. Nevertheless I have personally had considerable difficulty in presenting this classification to medical students and internes in such fashion that it will fulfill practical requirements as well as amplify the knowledge of pelvic anatomy. The difficulties are as follows:

First, the inclusion of so-called android types of pelvis and a complicating factor to what otherwise might be considered an anthropologic classification. To most of us the android pelvis means a masculine type of pelvis of funnel shape, with some peculiarities of inlet contour and unusual ruggedness of structure. It is generally associated with the less feminine type of individual, with irregular menstruation, infertility, and difficult labors. Actually, it represents a type of pelvis which has been subjected to environmental factors, namely, disturbance in the internal secretion and constitution of the individual. There seems hardly any more reason to include it in the so-called primary grouping than to include perhaps the rachitic pelvis or an osteomalacic pelvis.

In the second place, the authors of the Caldwell-Moloy classification seem to consider the transversely oval pelvis as the typical feminine pelvis and have labeled it gynecoid. Actually, there is no reason to believe that a transversely oval pelvis is more characteristically feminine than is a circular pelvis, or a pelvis with a slight increase of anteroposterior diameters over the transverse. To label it as such is rather falsely to assume that the individual is more feminine in her sexuality than is the individual with the round or oval pelvis anteroposteriorly, and to assume further that trends in development of the human female pelvis is in this direction.

If pelves must be classified from the general point of view of anthropology, would it not be better to limit this classification to the contour of the pelvic inlet? In this connection, I would subscribe to the classification proposed by Thoms of dolichopellic, mesatipellic and brachypellic, referring, respectively, to the anteroposterior oval, the round pelvis, and the transverse oval inlet. A second main grouping of pelves should bear upon the general size of the pelvis, namely: justo minor, or generally contracted; average; and justo major. Finally, a third grouping of pelves should give consideration to environmental factors. In this group there should be included the masculine type of pelvis, the pelvis affected by disease, rickets, osteomalacia, etc.; the pelvis affected by trauma; the pelvis affected by the congenital absence of one or more portions of the pelvis such as the Naegele or Robert pelvis, etc.

With these considerations in mind, a pelvis might be found "dolichopellic and average in size," or "generally contracted and rachitic" or "masculine in type and average in size," etc. With such terms, I think we might have something we could convey to our students.

In short, I dislike to give up the old classification based on environmental factors, and I really see no reason why one of them, the masculine type of pelvis, should be taken from this group and placed in a special classification otherwise based on anthropologic considerations. I know of no reason for calling the transversely oval pelvis feminine to the exclusion of other equally feminine types. If pelves are to be studied anthropologically, we must exercise some discrimination in our endeavor to establish a clinical classification on such criteria.

DR. STEELE (closing).—In reply to Dr. Montgomery, I would say that we are talking about morphology more than anthropology. It is the shape of the pelvis that is of interest in evaluating it from an obstetric standpoint.

The inclusion of the so-called sexual characteristics is incidental to the morphology. The android or the male form is important, for in all studies it has been found to be associated with more trouble than any other type of pelvis.

When classification is referred to provision is made for a description of the canal and the outlet. It should be remembered, however, that any kind of canal or outlet may be associated with any kind of inlet and for that reason we must have a very flexible system of classification. The great number of forms is, I think, justified since 50 per cent of the material examined was made up of mixed forms. Any change in either the anterior or the posterior segment of the pelvis alters its obstetric value.

Now as to the use of the so-called etiologic and pathologic forms in classification, I have to date examined about 1,600 pelves and I have yet to encounter one which we could not classify on its morphologic basis alone.

## OBSERVATIONS OF THE DEVELOPMENT OF PELVIC CONFORMATION\*

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DURING the last fifteen years considerable advance has been made in our knowledge of the human bony pelvis through the use of roentgenologic examination. Many workers have contributed to the newer knowledge. The well-known studies of Thoms<sup>1, 2</sup> and of Caldwell and Moloy<sup>3, 4</sup> deserve special mention. The most fundamental of the new conceptions which we have gained is that the adult pelves of both males and females vary considerably in final shape without relation to specific causative diseases. We now know, for example, that the inlet of the adult female pelvis may be broader than long, equally as broad as long, or longer than broad. While variations of this character have long been recognized, they have been correlated principally with race, or degree of civilization. It has been said by anthropologists that women of the more primitive races possessed pelves of the long oval type, like those of the great apes, while women of the more civilized peoples had pelves of the platypelloid shape. It took the roentgenologic studies of the last decade to reveal that considerable proportions of dolichopellic, mesatipellic, and platypellic pelves existed in our contemporary population. The obstetric significance of these variations has received much attention and clarification, but as yet very little work has been directed toward tracing the development of such variations, either in regard to the time of occurrence or to the etiology. Such questions as the following remain to be answered: Are the variations in shape which are present in adult women observable in young girls? Are such variations observable in the fetal period? In short, are individuals endowed with factors which make for a given pelvic shape, which they thereafter retain unless influenced by specific diseases, such as rickets, or do all individuals start out life with pelves which are essentially similar which only later become modified in form? If the latter supposition is true, what are the changes, when do they occur, and what brings them about? When do the sexual differences appear and what brings them about? It is with these phases of the subject that the present investigation concerns itself. In this report at-

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This study was made possible through a grant from the Christine Breon Fund.



tention is confined principally to two features, namely: The evolution of the shape of the female pelvic inlet and the development of the sexual differences in bony pelvis.

Most of our previous knowledge of pelvic development has been based upon the direct examination of fetal and adult pelvises, and a few studies of children's pelvises, based upon external measurements in living subjects. The majority of these studies were made during the latter part of the last century. So far as I am aware, roentgenometric examination has not previously been used for this purpose. The first real milestone in our knowledge of pelvic development was made by Litzmann,<sup>5</sup> who, in 1861, established the mechanical theory of pelvic development. He contended that trunk weight was one of the main factors in the formation of the final pelvic shape. On the assumption that the inlet of the fetal pelvis was longer than broad and that the inlet of the adult female pelvis was broader than long, Litzmann built up the idea that this change in shape was brought about through the sinking forward of the sacral promontory due to the increasing influence of trunk weight as the upright position was assumed. Shortly afterward Duncan<sup>6</sup> agreed with the fundamental changes in shape but gave a different explanation of the mechanics involved. On the other hand, Kehrer<sup>7</sup> believed that muscular tension or pull in extrauterine life was the principal factor in the development of the pelvic shape. In 1876 Fehling<sup>8</sup> published a detailed study of 130 fetal pelvises in which he concluded that the shape of the pelvis was determined by certain inherent properties or growth potentials, which were but little influenced by extraneous factors. He showed conclusively for the first time that the fetal pelvic inlet was broader than long and argued that trunk weight had little influence on the shape of the pelvis. As a corollary to his conception he believed that male and female pelvises could be distinguished even as early as the fourth month of fetal life. In 1899, Thompson<sup>9</sup> studied 8 fetal pelvises and came to similar conclusions with regard to the sex differences. In 1894 Konikow<sup>10</sup> measured the pelvises (external measurements) of 120 individuals ranging in age from birth to 20 years and came to opposite conclusions. He could discover no differences between the two sexes until after puberty. Williams<sup>11</sup> was inclined to agree with Fehling, though he never investigated the subject specifically. Recently Yamamura<sup>12</sup> reported a careful study of 140 fetal pelvises, one-half of which were male and one-half female. This author was the first to apply statistical analysis to his figures. He was unable to find significant differences between male and female pelvises, except for a slightly smaller posterior segment at the inlet and a slightly greater tendency to narrow toward the outlet in the males, though he seems to have accepted Fehling's idea that sex differences exist at an early period of fetal life. While many other authors have contributed to our knowledge of pelvic development, the broad outlines of the principal theories and facts are included above.

The material upon which the present observations are based consisted of 27 fetal pelvises, 10 female and 17 male, varying in age from three and one-half to ten months, which were studied and measured directly, and the roentgenometric examination of the pelvises of 98 girls and 45 boys, varying in age from three to eighteen years. Some observations upon a portion of the latter material, including the method of roentgenometric examination, have been reported previously by Morton and Hayden.<sup>13</sup> The fetal pelvises for the most part were from the collection of beautifully prepared fetal skeletons in the Department of Anatomy at the University of California. They were prepared and mounted by Mr. Rudolph Skarda.<sup>14</sup> This material was made available

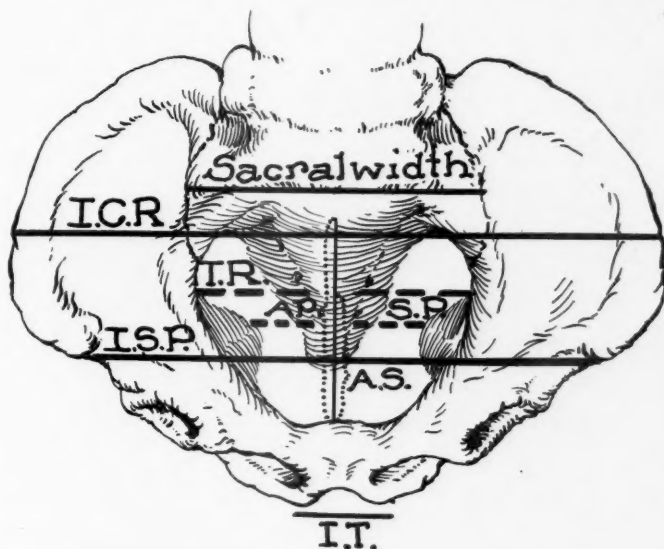


Fig. 1.—Diameters measured. Indices calculated (1) pelvic  $\frac{AP \times 100}{TR}$ ; (2) sacral  $\frac{sacral\ width \times 100}{ICR}$ ; (3) post. space  $\frac{AP}{AS}$

to me by Prof. John Saunders, who has given me invaluable assistance in this study. The pelvises were considered from the point of view of the size and shape of the inlet, the sacrum, the sacrosciatic notch, the pubic arch, and the pelvic outlet. Various diameters were measured and certain pertinent indices calculated as indicated in Fig. 1 and recorded in Table I. The pelvises were examined in the wet state in order to avoid changes in shape due to drying, and each measurement was made three times, the mean being taken as the final figure. Differences in the methods of preservation, whether wet or dry, have given rise to much of the confusion in results in the past. However, experience in making the measurements, many of which were of very small order, has convinced me that absolute accuracy is impossible. I, therefore, believe that conclusions based upon differences of fractions of a millimeter are not

justifiable, even when treated statistically, unless the number of cases is extremely large. This applies to the figures of Fehling and of Yamamura as well as to my own\*



Fig. 2.

Figs. 2 and 3.—Comparison of the pelvic inlet in fetal male and female pelvises of different ages.

In all of the fetal pelvises, male as well as female, the pelvic inlet was found to be similar and characteristic. In all instances the outline of the inlet was smooth, though rather squared off anteriorly. The shape of the

\*Scale drawings of the fetal male and female pelvises of comparable ages were made by Mr. Ralph Sweet and are reproduced in Figs. 2 and 3. They give a much better idea of the various characteristics than do the actual measurements.

inlet was that of a transverse ovoid, the greatest transverse diameter invariably exceeding the anteroposterior diameter. Casual inspection of the drawings gives one the impression that the inlet is longer than broad, whereas the reverse is true. The same thing obtained in examining the

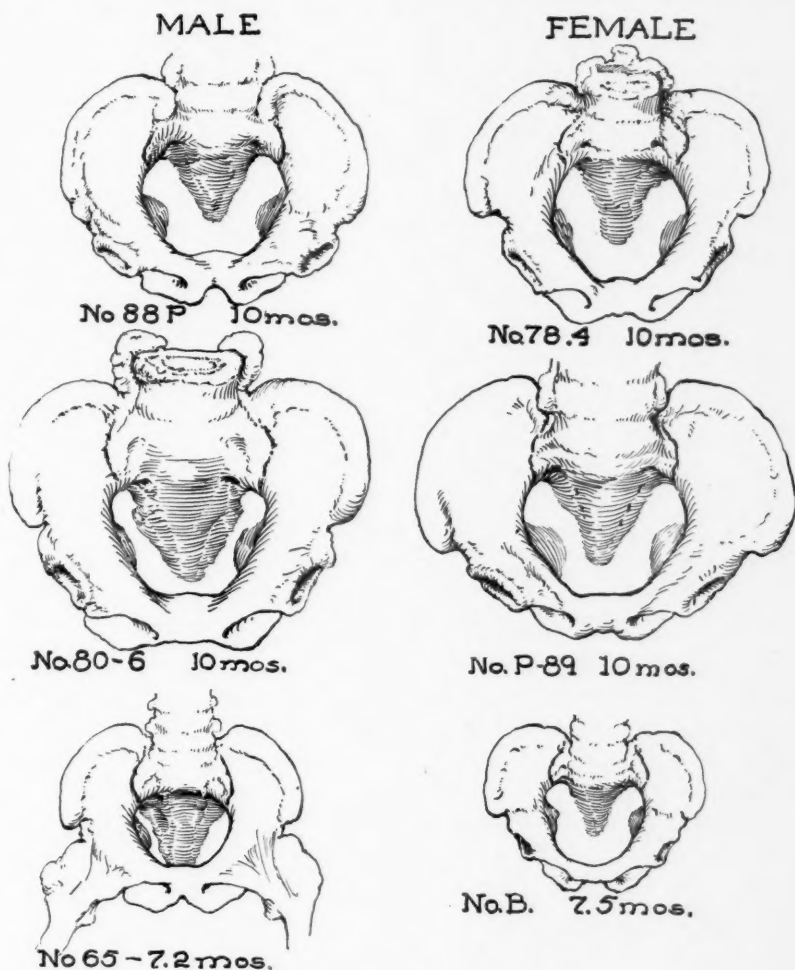


Fig. 3.

actual pelves. Reference to Table I reveals that the pelvic index of Turner ( $\frac{\text{Anteroposterior diameter of inlet} \times 100}{\text{Greatest transverse diameter of inlet}}$ ) fell below 90 in all instances except two; in the two exceptions the indices were 91 and 96, respectively. These figures give mathematical expression to the broader than long shape of these pelves.

The sacrum presented a rather straight flat surface, forming a more obtuse angle with the lumbar spine than one finds in later life. Before

the fourth month of fetal life the sacrum was almost straight; from the fourth to the tenth month one could observe a definite curve, which did not change appreciably during this period. The first sacral vertebra occupied a higher position than it does in children and adults, so that the posterior extremity of the anteroposterior diameter of the inlet fell not at a promontory formed by the upper border of this vertebra but at the upper border or the middle of the second sacral vertebra. This means that the anteroposterior diameter of the pelvic inlet in the fetus is not directly comparable to that which is observed roentgenologically in the adult, in the sense that the posterior extremity of this diameter lies at a much lower point on the sacrum in the former case than it does in the latter. From the viewpoint of an "obstetric conjugate," they are comparable, for in this sense they are both measures of anteroposterior space at the inlet. Both Fehling and Yamamura made similar observations regarding the position of the sacral promontory. However, even if one employs the upper border of the first sacral vertebra as the posterior extremity, the anteroposterior diameter is still smaller than the greatest transverse measurement.

Except for general increase in all diameters, there were no marked changes in the shapes of the fetal pelvises from the youngest to those of term size. The drawings illustrate this well.

In agreement with Yamamura, I was unable to distinguish sexual differences, though the small number of pelvises does not permit unqualified conclusions. Both Fehling and Thompson believed that they could make sexual distinctions as early as the fourth month and the latter described for his fetal male pelvises the well-known characteristics of adult male pelvises, such as a narrowing toward the outlet, narrower interischial spines and tuberosities, and a narrower sacrosciatic notch. However, Thompson's conclusions were drawn from a comparison of four male with four female pelvises and may well be untrustworthy. In my material, both the sacrosciatic notches and the subpubic angles varied considerably in individual specimens. Neither was characteristically wide nor narrow in the respective sexes. There were no statistically significant sexual differences in the pelvic index, the sacral index, nor in the position of the greatest transverse diameter of the inlet (Table I). Yamamura's detailed observations support these findings, except for the last item mentioned. His figures indicated that in the male the greatest transverse diameter of the inlet lay closer to the sacrum than it did in the female.

I have no observations bearing upon the changes in the pelvis from birth to three years of age. Konikow's study indicated that there was a striking increase in both the transverse and the anteroposterior diameters of the pelvis in the first year of life but that the anteroposterior diameter increased at a much slower rate than did the transverse diameters in the following four years. This fact he attributed to the in-



TABLE I. MEASUREMENTS OF 27 FETAL Pelves IN MILLIMETERS. AGE BASED ON SITTING HEIGHT (STREETER), TOTAL LENGTH, AND MENSTRUAL HISTORY

NO.	SEX	LUNAR MONTH AGE	PELVIC INLET			ICR M.M.	ISP M.M.	SACRAL WIDTH M.M.	ISCHIAL SPINES M.M.	INTERTUBEROSITY M.M.	AP AS	SACRAL INDEX	PELVIC INDEX
			TRANS. M.M.	A.P. M.M.	ANT. SEGMENT M.M.								
81	M	3.3	6.2	4.3	2.4	14.9	13.1	7	5.6	2.7	1.791	49	69
44	M	3.5	7.3	7	5	18	16.1	8.8	-	4.2	1.400	44	96
64	M	3.7	8.1	6	4	19	17	10	4.9	4	1.500	53	74
50	F	3.8	9.6	7	5	23	20.5	10	7	5	1.400	44	73
49	F	4.0	9	7	5	22.9	21.2	10.4	6	4.7	1.400	45	78
86	M	4.1	9	7	5.1	20.8	19	10.1	5.9	5.5	1.372	48	78
84	M	4.2	9.9	7	5.8	24.1	23	11	5.5	4.4	1.207	46	71
43	F	4.5	11.2	9.9	6.9	27.7	26	14	8.1	6.2	1.434	51	88
79-5	F	4.5	13	10	6.5	32.2	29.1	13.4	8.5	6.2	1.538	42	77
82	M	4.6	13	10.3	7	31.3	29	14	9.7	7	1.471	45	79
8	M	4.8	12.9	10.7	8.1	33	30.1	14	9.9	6.7	1.320	42	83
85	M	5	13.2	11	8	33.5	29.8	15.9	8.5	6.4	1.375	43	83
88	F	5.3	15.2	12.2	9.2	40	37.2	17	11.4	9.2	1.326	43	80
42	M	5.3	15	12.1	8.6	38	34.5	17.2	9.4	8.1	1.406	45	81
77-3	M	5.5	16	13	9	40	37.6	16.2	10.5	10.6	1.444	41	81
76-2	M	5.5	16.2	12	7.7	38	36.3	17.4	10.2	10.6	1.558	46	74
45	M	6.2	18	14.7	10.4	45	42	20	12.7	9.2	1.413	44	82
81	F	6.5	20.2	17.1	11.9	48	44.7	22.6	13.8	10.8	1.437	47	85
65	M	7.2	22.7	18	12.7	53.1	50	24	16	11.9	1.417	45	79
B	F	7.5	22.3	16	-	48.2	44	24	18	17.4	-	49	72
80	M	8	24.6	20.5	14	57	55.1	26.2	17.9	17.1	1.464	46	83
Mt.	M	8	23.6	21.4	13.8	53.2	51	24	17	17	1.550	45	91
P-90	F	10	34.5	23.1	16.6	71.7	65.5	32.6	22.3	21.3	1.391	45	67
P-89	F	10	36	27.5	17	82	78.1	33.8	26	24.3	1.617	41	76
80-6	M	10	35.5	31.7	21	77.9	72.2	39	31.9	20.9	1.509	50	88
78-4	F	10	30.6	27.4	18.2	70	67.7	32.8	28	26	1.505	47	90
P-88	M	10	31.6	25	16.8	68.9	63.1	35.4	23.6	22.6	1.488	51	79

Pelvic Index  $\left( \frac{AP \times 100}{TR} \right)$  - Mean for { Females - 78.6 } { Males - 80.6 } Standard error of Difference = 1.054  
 .. not significant

Sacral Index  $\left( \frac{SW \times 100}{ICR} \right)$  - Mean for { Females - 45.4 } { Males - 46.3 } Standard error of Difference = 1.31  
 .. not significant

Posterior Space  $\left( \frac{AP}{AS} \right)$  - Mean for { Females - 1.449 } { Males - 1.484 } Standard error of Difference = 0.075  
 .. not significant

TABLE II. THE DETAILS OF THE 27 CASES IN WHICH REPEAT EXAMINATIONS WERE MADE

NUMBER	NAME	AGE YR.	PELVIC INLET			AP AS	PELVIC INDEX AP $\times$ 100 TR
			TRANS- VERSE CM.	ANTERO- POS- TERIOR CM.	ANTERIOR SEGMENT CM.		
111311	Clowdus	3	6.6	6.8	3.9	1.743	103
146059	Clowdus	6	7.4	8.4	5	1.680	114
117661	Hunt	3	7.6	7.8	4.3	1.813	102
157022	Hunt	7	8.6	8.6	5.5	1.563	100
115291	Roth	4	6.6	6.2	3.9	1.589	94
155513	Roth	7	7.7	7.7	5.1	1.509	100
107193	Latierzo	4	7.5	7	4.2	1.666	93
154797	Latierzo	8	8.5	8.5	5.1	1.666	100
117304	Holt	4	8	8	4.9	1.550	100
154334	Holt	8	8.3	8.9	5.8	1.534	107
112259	Filice	6	7.2	7.1	4.1	1.710	99
157024	Filice	10	7.4	8	4.8	1.666	108
116965	MacIntyre	7	8	8.5	4.1	1.670	106
153404	MacIntyre	10	8.7	9.3	6.5	1.431	107
106428	Piccini	8	8.9	9	5.9	1.525	101
129814	Piccini	10	9.5	9.6	6.5	1.476	101
145315	Piccini	12	10.3	10	6.5	1.538	97
107316	Smith	8	8.5	10	6.8	1.470	117
152740	Smith	12	10.3	11	7.3	1.507	107
119016	Taylor	8	7.2	8	5	1.60	111
152690	Taylor	11	7.9	9	5.9	1.525	114
119210	McLean	8	8.6	10.5	6.2	1.69	122
145987	McLean	10	9.9	10.9	6.5	1.677	110
106224	Dorado	9	8.6	9.5	6.5	1.461	110
145989	Dorado	13	11.3	10.5	7.1	1.479	93
106782	Sordello	10	9.6	10.8	7	1.54	112
151980	Sordello	13	13	12.3	7.7	1.597	95
115759	Morton	10	8.4	9.8	5.5	1.78	116
129554	Morton	11	9.6	10.5	5.8	1.81	109
145314	Morton	12	9.8	10.2	5.9	1.729	104
118240	Phillips	10	7.8	10.1	-	-	129
152530	Phillips	13	8.6	10.4	6.7	1.552	121
116902	Hantnee	11	8.5	9.8	6.7	1.463	115
145973	Hantnee	13	8.9	10.5	6.5	1.615	118
109078	Hofmann	11	9.5	10	6.5	1.54	105
152224	Hofmann	15	11.8	10.12	6.6	1.545	86
106895	Hengst	11	9.5	11.5	7	1.57	121
151476	Hengst	15	12	12.6	7	1.80	105
110909	Azevedo	11	8.8	10.5	6.1	1.721	119
152864	Azevedo	14	11.2	12	6.9	1.739	107
110879	Johnson	11	9	10.6	7.1	1.492	117
129814	Johnson	12	10.1	11	7.6	1.447	109
145317	Johnson	13	10.8	11.4	7.3	1.561	106
156811	Johnson	14	12.1	12.2	7.6	1.601	101
108347	Pina	11	9.5	9.8	6.3	1.55	103
151226	Pina	14	12.5	11.2	7	1.60	90
106778	Misenheimer	11	11.4	9.3	6	1.55	82
151766	Misenheimer	15	11.7	10.1	6.6	1.53	87
105622	Silverman	12	9	11	6.7	1.641	122
131354	Silverman	14	11	11.4	6.6	1.727	104
145316	Silverman	16	11.1	12	6.6	1.818	108
106671	Debekker	12	9.5	10.2	6.5	1.569	107
152027	Debekker	16	12.8	11.4	6.8	1.676	89
116002	Aceves	12	9.4	10.5	6.4	1.646	111
151702	Aceves	15	11.5	11.5	6.5	1.769	100
117661	Iannochona	12	11.3	12.3	6.2	1.983	109
157028	Iannochona	15	12	13.2	6.8	1.919	110
111350	Martin	13	11.2	11.5	6.6	1.742	102
153117	Martin	17	12	11.7	7.3	1.602	98

fluence of trunk weight. With Litzmann, he believed that as the child begins to walk the weight of the trunk is thrown anterior to the sacral promontory, which, therefore, sinks downward and forward as the sacrum rotates about a transverse axis in the region of the third sacral vertebra. The combination of this factor with the upward thrust of

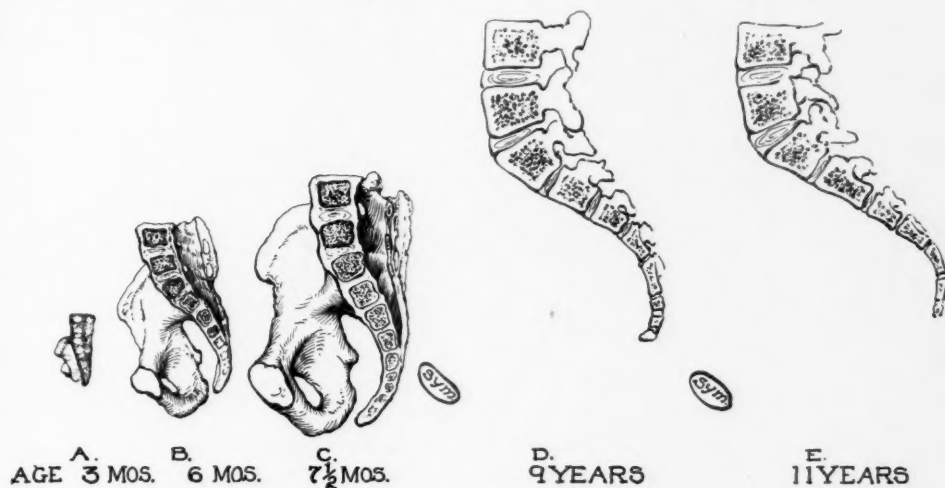


Fig. 4.—Illustrating the greater curvature imparted to the sacrum by the downward and forward movement of the promontory after the assumption of the upright position and walking.

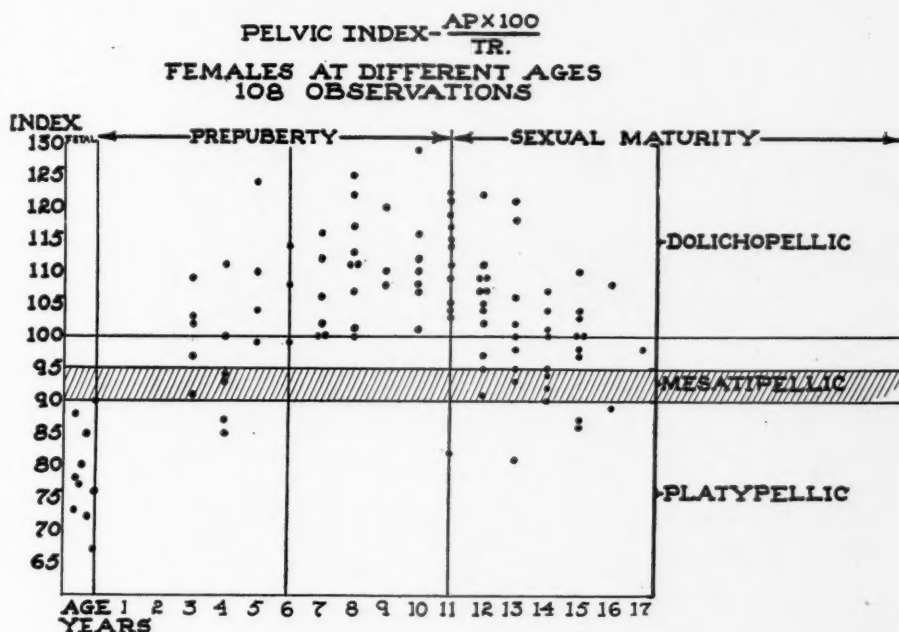


Fig. 5.—Illustrating the shift in the shape of the pelvic inlet at different ages.

the femora tends to retard the increase in the anteroposterior diameter of the inlet, while the sinking forward of the sacral promontory results in an approximation of the posterior-superior spines of the ilia and thus a relative increase in the transverse measurements. Whether the

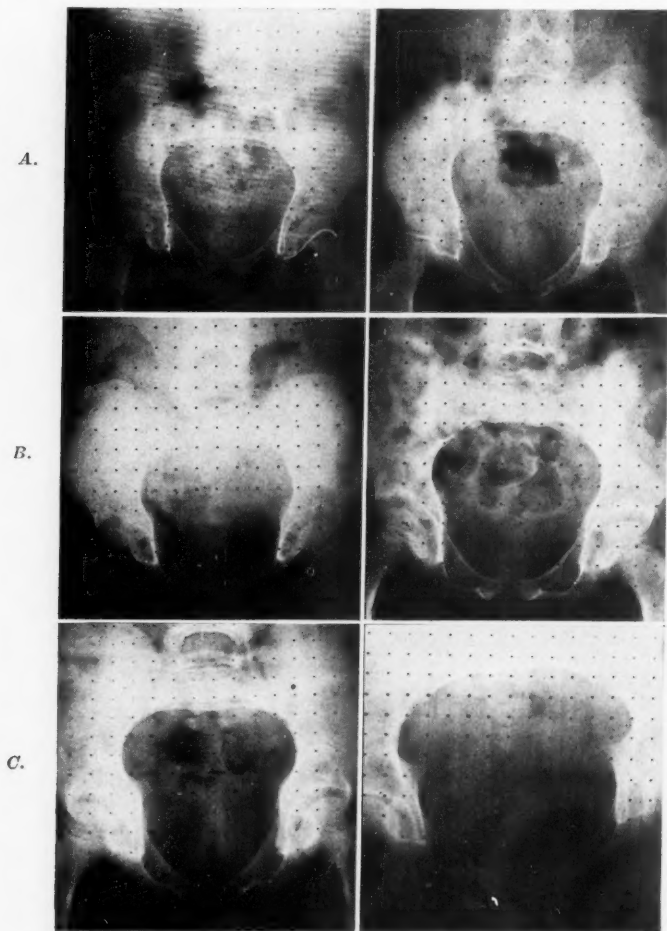


Fig. 6.—A, Girl, N. R. (No. H-115291 and H-155513). B, Girl, D. L. (No. H-107193 and H-154797). C, Girl, E. D. (No. H-106224 and H-145989). Two studies in each of three girls at different ages. A and B illustrate tendency to anteroposterior elongation of the pelvic inlet after approximate aged 6 years. C illustrates smoothing of the outline of the pelvic inlet and tendency to flattening as the child matures.

downward and forward movement of the promontory is due to trunk weight or to changes incident to a set pattern of bone growth as Fehling believed can only be speculated. The fact is that the movement occurs. The changes in position are well illustrated in Fig. 4.

The observations made in our previous roentgenometric study of children's pelves have been further documented. It was observed that until the age of puberty (11 years), there was little difference in the pelves

of boys and girls. The pelves of children three, four, and five years of age showed an inlet which was either round or broader than long in most instances. From age six years through age eleven years the pelves presented oval inlets, with the greatest diameter being the antero-posterior one. After eleven years, increasing proportions of the pelves

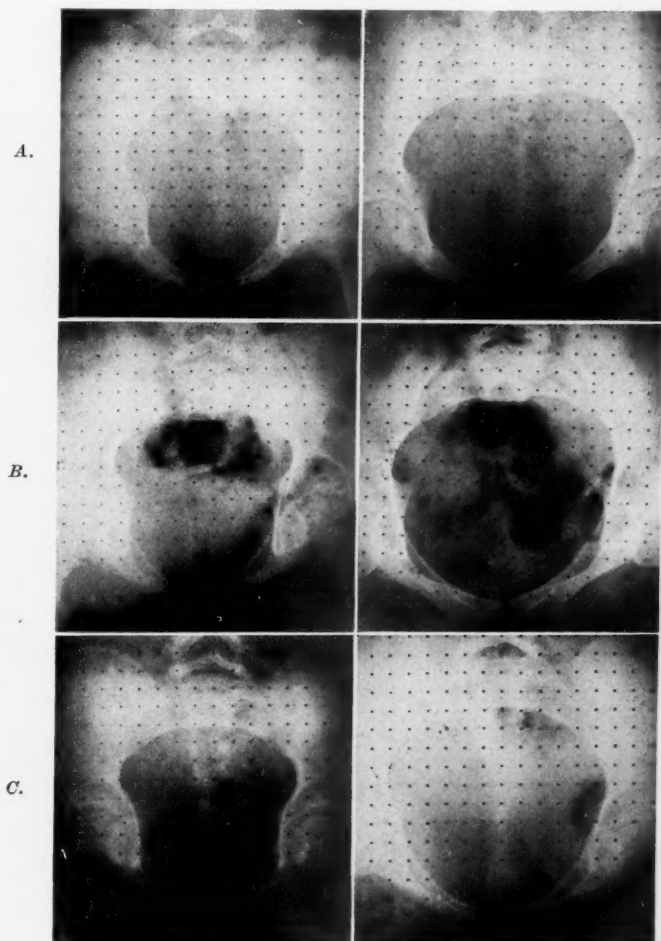


Fig. 7.—A, Girl, I. P. (No. H-108347 and H-151226). B, Girl, N. H. (No. H-106895 and H-151476). C, Girl, J. A. (No. H-116002 and H-151702). Additional serial studies in each of three girls. All illustrate the smoothing of the outline of the pelvic inlet and tendency to flattening as the child matures.

of the girls showed inlets which were again broader than long. The graph of pelvic indices (Fig. 5) illustrates these shifts in inlet shape graphically. All figures above 100 indicate inlets which were longer than broad. One other fact of interest was that in all of the children eleven years of age or younger, the inlet of the pelvis did not present a smooth outline but showed an inward bowing in the regions of the



acetabula, presumably due to the upward thrust of the femora. This was true in all of the children under eleven and invariably disappeared as maturity was reached.

In order to determine whether changes actually occurred in individuals as the above observations would seem to indicate, repeat studies

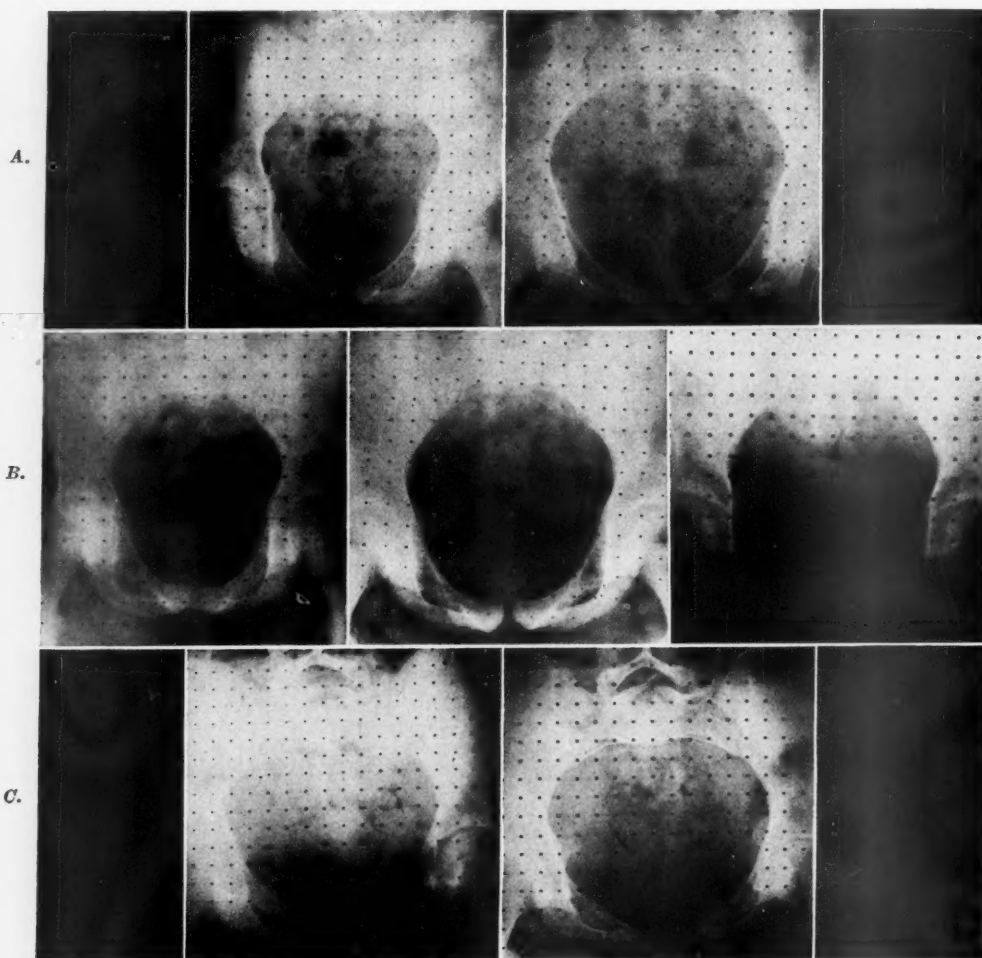


Fig. 8.—A, Girl, E. D. (No. H-106671 and H-152027). B, Girl, L. M. (No. H-115759, H-129554, and H-145314). C, Girl, I. M. (No. H-106778 and H-151766). A, Studies of the pelvic inlet in the same individual aged 12 years and 16 years, illustrating the smoothing of the outline of the pelvic inlet and the tendency to flattening as the child matures. B, similar studies in another individual showing retention of the anthropoid shape. C illustrates adult gynecoid shape at aged 11 years (possibly due to early puberty), with no further change in the shape four years later, though the size has increased.

were obtained in 27 of the cases. As expected, actual changes were observed (Figs. 6 to 8).

When repeat films were obtained in children originally studied at ages three, four, or five years, it was found that the inlet had changed in the three- or four-year interval from a round or broader than long

shape to a longer than broad, or dolichopellie shape. When pelves, originally studied between the ages of six and twelve years, were re-studied at fourteen or fifteen years it was found that the inlet had lost its inward bowing in the acetabular regions and, in most instances, the inlet showed some degree of flattening again. The details of these repeat studies are given in Table II and are graphically illustrated in Fig. 9. While it seems likely that Fehling's idea of predetermined or inherited growth potentials as the main determinant in pelvic development is fundamentally sound, Konikow's observations and the facts presented point to other determinants as well. The assumption of the upright position, with the consequent upward thrust of the

**CHANGES IN PELVIC INDEX WITH CHANGES  
IN AGE**  
**27 INDIVIDUALS— $P.I = AP \times 100 / TR.$**

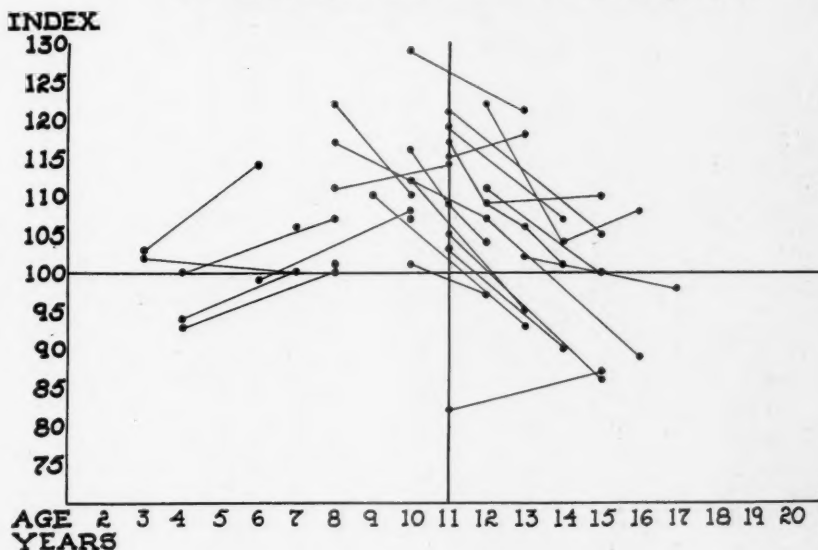


Fig. 9.—Illustrating the shift in the shape of the pelvic inlet at different ages in individuals.

femora seems to have a definite effect upon the shape of the pelvis, at least, it produces an inward bowing of the pelvic outline. What causes the change in the shape of the pelvis from platypelloid or round to dolichopellie in the years six to twelve can only be guessed. More violent running and walking while ossification is still incomplete, or sitting on school benches for long hours, or some entirely unknown factor may be responsible. In any event, the uniformity of this finding is striking. The tendency to flattening again after puberty most logically can be coupled with the appearance of the sex hormones. The reason for the retention of the dolichopellie shape by some individuals, and the assumption of varying degrees of flattening by others, is not clear. Nutri-

tion, or variations in responsiveness to the sex hormone, or variations in the quantity of the hormone itself may be responsible.

The roentgenologic studies revealed no striking sexual differences before the age of puberty (eleven years was taken arbitrarily as the

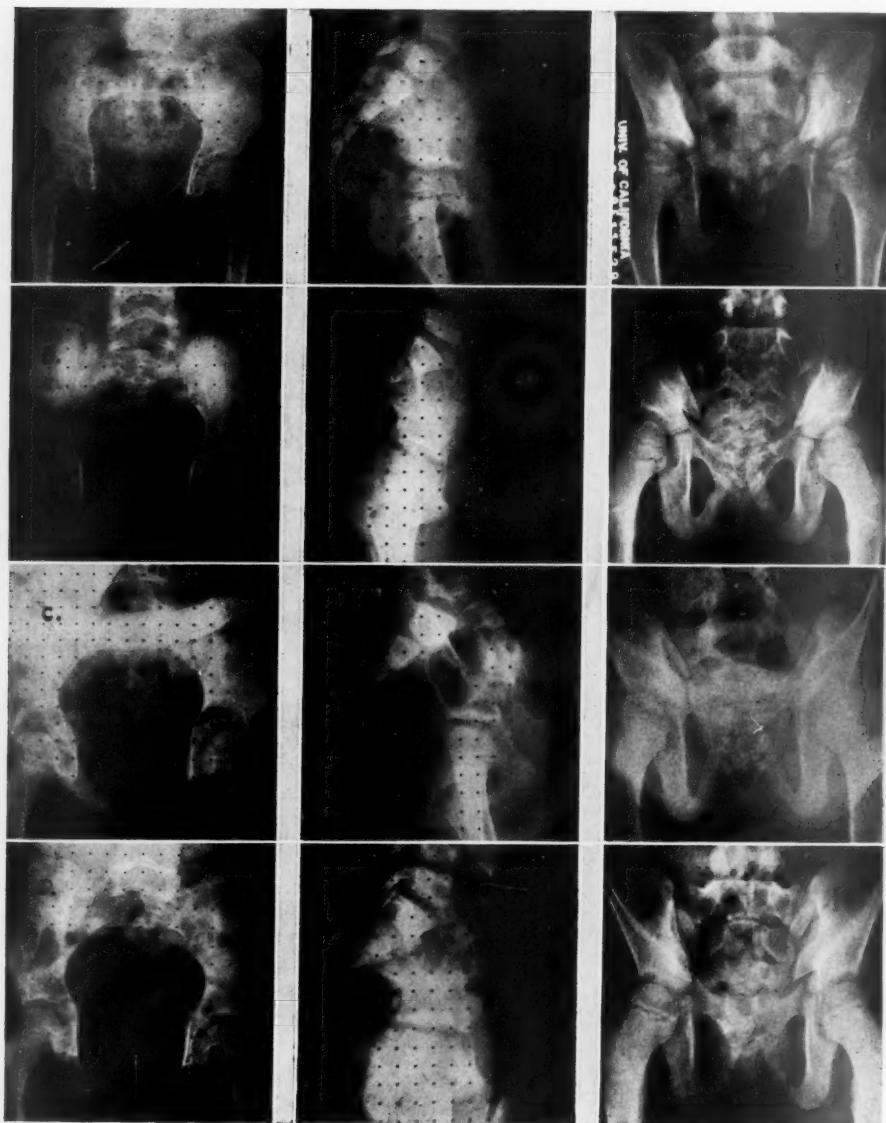


Fig. 10.—Comparison of the pelvises of boys and girls of the same prepuberty ages. Note the marked similarity in all views. A, Girl, aged 5 years. B, Boy, aged 5 years. C, Girl, aged 7 years. D, Boy, aged 7 years.

dividing line, with the full realization of individual variations from such an age), with two possible exceptions, as follows: (1) The position of the greatest transverse diameter of the inlet was slightly closer to the

sacrum in the boys than it was in the girls (see  $\frac{AP}{AS}$  in Table III), and (2) the downward curve of the sacrum differed in the two sexes, while actual measurement of the distance from the symphysis to the middle of the third sacral vertebra (*S3*) and to the inferior border of the fifth sacral vertebra (*S5*), and measurement of the sacrosciatic notch (*SSN*) revealed no significant differences between means, and while the notches failed to differ in general appearance, the male sacrum took a rather abrupt downward swing just above its midpoint, whereas the female sacrum did not (Table III).

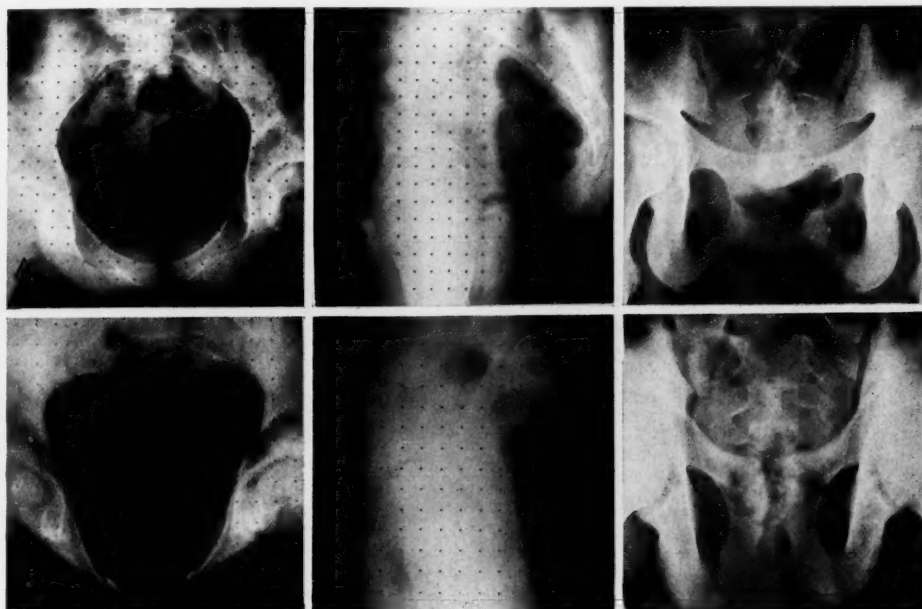


Fig. 11.—After puberty marked sexual differences appear. A, Girl, aged 15 years. B, Boy, aged 17 years.

After eleven years of age the well-known characteristics of adult female and male pelves began to crop up and became increasingly apparent as the children were older (Figs. 10 and 11).

From the evidence at hand, it appears that only minor differences, possibly entirely insignificant, exist between the bony pelves of males and females before puberty. At this time the pelves of each sex take on definite characteristics which differ materially. It is felt that this is probably associated with the great increase in the sex hormones which is known to occur at this time, causing the marked genital and secondary sexual development so characteristic of this period.

More concrete substantiation of the idea that pelvic shape can be influenced by sex hormones is offered by the animal experiments of Hisaw,<sup>15</sup> in 1925, and Gardner,<sup>16</sup> in 1936. The former, working with the

TABLE III. COMPARISON OF CERTAIN INDICES AND MEASUREMENTS IN BOYS AND GIRLS OF PREPUBERTY AGE. IN ONLY ONE RESPECT IS THERE A STATISTICALLY SIGNIFICANT DIFFERENCE. THE POSTERIOR SEGMENT OF THE INLET IS SMALLER IN THE MALE

INDEX OR MEASUREMENT	GIRLS 11 YEARS OF AGE AND LESS			BOYS 11 YEARS OF AGE AND LESS			COMMENT		
	NUMBER OF OBSERVATIONS	MEAN	STANDARD DEVIATION	NUMBER OF OBSERVATIONS	MEAN	STANDARD DEVIATION	THE DIFFERENCE	STANDARD ERROR OF DIFFERENCE	SIGNIFICANT
AP*	53	1.605	0.0774	34	1.549	0.0953	0.056	0.0194	Probably
AS	56	107.4	17.94	34	107.5	9.69	0.1	3.34	No
AP × 100 TR	49	10.48	0.71	32	10.72	0.642	0.24	0.1519	No
S3 Related to AP as 10 cm.	49	10.24	1.05	32	10.21	0.753	0.03	0.2056	No
S5 Related to AP as 10 cm.	46	3.86	0.46	28	3.71	0.469	0.15	0.112	No
SSN Related to AP as 10 cm.									

\*AP represents the anteroposterior diameter of the inlet. AS represents that portion of the anteroposterior diameter which is anterior to the greatest transverse diameter. The smaller this quotient the closer is the greatest transverse diameter to the sacrum.



pocket gopher and the latter with rats, demonstrated that the pelves of castrate and noncastrate males could be made to assume female characteristics by the administration of an estrogen.

#### SUMMARY AND CONCLUSIONS

The direct study of 27 fetal pelves of various ages and the roentgenometric study of 143 children of both sexes, from 3 to 17 years of age, revealed interesting observations with regard to the development of the shape of the pelvic inlet and the development of sex differences in pelves.

The shape of the inlet was found to be broader than long at all periods of fetal life. There were no significant sexual differences. In children under six years of age the inlet was still either broader than long or round in most instances. From six to eleven years of age the pelvic inlet was invariably longer than broad. In all of the children of prepuberty age the outline of the pelvic inlet was not smooth but showed an inward bowing in the acetabular regions, presumably due to the upward thrust of the femora. This bowing was not present in the fetal pelves nor in the pelves of children in the postpuberty age group. After puberty the pelvic inlet of the female pelves showed a tendency to flattening, so that many of them again became broader than long. These changes were demonstrated in individuals by serial studies at two- to four-year intervals.

No significant sexual differences were observed in the fetal period, though the number of pelves was too small to exclude minor variations. In the years before puberty a comparison of the roentgenograms of male and female pelves (inlet view, side view, and subpubic arch view) revealed only two possible differences, to wit, a shorter posterior segment at the pelvic inlet in the male and a downward angulation of the sacrum in the male. After puberty the well-known characteristics of adult male and female pelves were observed. While it is impossible to deny categorically that differences do exist between the male and female before puberty, certainly the major differences appear at this time.

The finding of a common type of pelvis in fetal life and in children before puberty, both of which are different from adult types, and distinct differentiation after puberty, suggests that the sex hormones play a large role in the development of the final pelvic form, not only with regard to sexual differences but possibly also with regard to variations in pelves of the same sex. It cannot be denied, of course, that hereditary, nutritional, or possibly other as yet unknown, factors may play a role.

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## DISCUSSION

DR. WILLIAM E. CALDWELL, NEW YORK, N. Y.—Dr. Morton has studied 27 fetal pelves, carefully dissected and mounted by expert anatomists. This is a much larger series than Thompson's 8 cases and is the largest collection which has come to my attention. The dissection and mounting of fetal pelves and even the pelves of older children without distortion requires a great deal of expert care. I hope that more collections similar to Dr. Morton's will become available for study and that the pelves of children that come to autopsy will be thoroughly studied and that many of them will be preserved.

I agree with Dr. Morton that the measurements of the cardinal diameters in these very small pelves and especially in a small series have very little significance. It is the morphology of the pelvis as a whole which counts. The study of the pelvis in the live individual by external measurements is practically useless in describing the shape of the true pelvis.

His second approach is the use of the x-ray in studying the pelvis of the living individual. I have been amazed at the amount of detail and accuracy which can be obtained in carefully taken roentgen ray films, even in fetuses.

I wish Dr. Morton had not been so positive in his conclusions that sex variations before puberty are negligible. I do not think that contemporary anthropologists will agree with him in this statement. Dr. Wesley Dupertuis, after reading Dr. Morton's paper, made the following note: "As an anthropologist having worked in the laboratory of Dr. Hooton, and perhaps having been influenced by his ideas, I have always felt that it was possible to determine the sex in the pelves of children, infants, and perhaps those of fetuses. Certainly from the osteologic material that I have seen, there seem to be tremendous differences in the pelves of small children. From Todd's own material and from the impression that I have gained from Hooton and Hrdlicka's work, I believe that most anthropologists feel that pelvic sex differences are evident in early childhood and perhaps even in the intra-uterine period."

Six years ago we examined the pelves of 28 girls and 15 boys shortly after birth. Since that time we have examined a great many more pelves, both boys and girls, normal and abnormal. In view of Dr. Morton's statement, we have reviewed many of the cases and still feel that the conclusions published in the *American Journal of Roentgenology and Radium Therapy* (Vol. 41) are correct: "Fehling and Thompson have shown that many of the sexual differences as illustrated and described for the typical male and female pelves can be recognized in the fetal pelvis early in intrauterine life. Recently we have studied the roentgenologic appearance of the fetal pelvis shortly after birth. In addition to the recognition of sexual differences, we have observed variations in inlet shapes in the female child which suggest anthropoid and android types."

Dr. Morton acknowledges that there are these sex variants but claims that they are not significant until after puberty. Of course the most significant changes are at puberty, but anthropologists believe that the sixth year, when the second teeth appear, is almost as important as puberty in the growth and development of the child. As Dr. Morton has said, it is about this time that the long transverse oval of the infantile pelvis changes into the long anteroposterior oval. It is the time also when the pushing forward into the pelvic cavity of the acetabulum begins to occur. Thyroid and other endocrine studies at this time would be interesting.

From Dr. Morton's own pictures, I have selected two cases which certainly are typical male and female pelves, as marked as in any individual adult. In Thompson's slides the differences are very marked. In our own which have been re-examined over and over again, the sex overlaps occur in both sexes and are easily determined. I agree with Dr. Morton on the position of the inlet in fetal life. I wish Dr. Morton would add one more picture to his series in order to study the pelvis from inlet to outlet by stereoscopic examination, for there is no doubt that for the study of the morphology of this pelvis from inlet to outlet the stereoscopic examination gives much more information than flat pictures. The precision stereoscope is not essential but it does reduce the amount of distortion and error.

Dr. Steele's paper which follows will point out some objections to Dr. Thoms' technique. Dr. Thoms' best pictures are obtained in the anthropoid type of pelvis, where it is easy to have the film parallel to the inlet. As the angle between the spine and the inlet decreases and becomes more acute, as in the android pelvis, it is difficult to have the film absolutely parallel with the inlet. A ten-degree variation in the inclination of the pelvis and the film completely distorts the forepelvis. I believe that is the reason that Dr. Thoms does not recognize the android pelvis and has left it out of his classification.

I hope Dr. Morton will continue his work and that more clinics will use x-ray techniques to study the development of the pelvis. Front, back, and lateral pictures of the child, with x-rays of the pelvis, preferably stereoscopic, should be taken at birth and possibly each year through puberty. Careful x-ray examinations of the pelvis, backed by adequate histories of the minor as well as the serious injuries, the various infections and diseases of the child, the metabolic deficiencies, and especially our constantly increasing information regarding the function of the endocrine glands will in time add to our knowledge of the etiologic factors which produce the complex osseous structure of the adult pelvis.

DR. PAUL TITUS, PITTSBURGH, PA.—Dr. Morton's outline of the general types of pelves found in fetal life and in infancy up to puberty was complete in every respect. I did not get Dr. Caldwell's impression that Dr. Morton intended to convey that there were no outstanding sexual differences between girls and boys before the period of puberty. It was my impression he stated that these changes do begin in that particular period but are more evident at the time of puberty and immediately following. Dr. Morton did say that all children show a general characteristic change in the shape of their pelves when they change from infancy into youth and he conjectured that these changes, platypelloid to a dolichopellic, result from trochanteric pressure on the sides of the pelvis from playing and running, as children do, while ossification is still incomplete.

As evidence of the correctness of Dr. Morton's conjecture I might recall to you the comments that Dr. Williams used to make as to the reasons for certain changes occurring in a coxalgic pelvis. He said that if the disease was on the left side the person would favor that side and strike harder on the sound right side. Hence the indentation of the pelvis would be on the side opposite the diseased hip, this being possible because ossification was still incomplete. That fits in very well, I think, with what Dr. Morton has said regarding the narrowing from side to side and the lengthening of the pelvic inlet.

Another point that attracted me was the fascinating possibilities that lie in continuing these studies over a considerable period of years in the same individual, following each one from infancy to adult life. Dr. Morton evidently intends to do this, having begun already to repeat some of his studies begun in children now growing older. When these children can be followed into adult life what are now plausible conjectures will be matters of record, no doubt.

DR. HERBERT THOMS, NEW HAVEN, CONN.—Recently Dr. Greulich and myself have concluded just such a study as Dr. Morton suggests. We have followed 107 orphanage girls for over four years through puberty, and have taken a roentgenogram of each girl at intervals of one year. I have lantern slides which almost duplicate those which Dr. Morton has shown. I would like simply to read our conclusions.

This study was based upon 107 orphanage girls on whom pelvic roentgenograms and anthropometric observations were repeated at intervals of approximately twelve months over a period of four years.

*Conclusions.*—a. The shape of the pelvic inlet is very similar in boys and girls up to the time of puberty.

b. Growth of the pelvis up to the time of puberty (so far as it can be followed in the anteroposterior film) is slow and symmetrical. During the prepuberal period the acetabular constriction is well marked.

c. At about the time of puberty in girls, usually just prior to the first menstruation, but sometime after the development of breasts has begun, a relatively rapid growth and remodeling of the inlet occurs. This is usually completed within eighteen months to two years after the menarche. Thereafter very little growth or change in shape of the inlet was noted. It seemed to have attained practically its adult size and configuration.

DR. HOWARD C. MOLOY, NEW YORK, N. Y.—Dr. Morton's work brings up two important points. The first deals with the presence or absence of sexual differences in the pelvis of the fetus, infant, or child; the second concerns the changes in the morphology of the pelvis produced by growth and development quite distinct from the sexual characteristics in pelves.

Six years ago, as Dr. Caldwell has stated, we obtained stereoroentgenograms on forty-three infants shortly after birth and from their study believed we recognized distinct sex differences thereby confirming the work of Fehling and Thompson both of whom reported the recognition of sex differences in young fetuses. Dr. Morton also recognizes sex differences in infants and children but believes these differences are too slight to warrant consideration. This introduces a controversy which we believe should be settled before theories are evolved in regard to the action of the growth hormones from the application of one or the other points of view. We shall attempt to obtain a repeat roentgenologic examination upon the original series of forty-three cases examined six years ago and report our findings because of the great importance of this particular point.

With regard to the second point, I believe Dr. Morton's paper represents an important contribution. We have also observed the acetabular bulging and have noted a great variation in the age limits for epiphyseal lines to form and disappear. The pelvis appears to increase in length through growth at the ilium, ischium, and pubis during the period of infancy and early youth. Later the sacrum increases in width to effect an increase in transverse diameters. However, this suggestion can be proved by only one method, the study of stereoroentgenograms obtained at intervals upon the same individual. This type of study requires many years to obtain significant information yet the question is important enough to warrant a beginning in several clinics.

DR. JOSEPH L. BAER, CHICAGO, ILL.—There is a pelvic factor which I should like very much to have the essayist touch upon in his closing remarks, namely pelvic inclination. This is one of the important osseous components with which we are concerned.

I believe that 20 to 25 per cent of displaced uteri are displaced because of the defective pelvic inclination which that group of women exhibit. The gross sagittal section of the pelvis in women with uterine displacements shows that the promontory is at a much higher level in relation to the symphysis than in the normal mature female. There is a vertical wall posteriorly, as the essayist showed, for the sacrum undergoes no curvature during fetal life.

DR. FREDERICK H. FALLS, CHICAGO, ILL.—I am very much impressed with Dr. Morton's contribution, particularly as it is based on actual measurements of the dissected specimens of the pelvis and believe this is the way we are going to get information that will last rather than by x-ray pictures. After all, x-ray pictures are shadows and they are none too reliable, even though we have gone a long way toward making measurements from those shadows more reliable by our modern methods of mensuration.

The second thing that impressed me was that this work may explain the dystocias that occur in very young women who are in labor. It has been difficult to see why some of these patients have so hard a time, and this inward bowing of the sides of the inlet of the true pelvis, which would be very difficult to detect clinically, may be the explanation.

If you look at the pregnant woman as a whole you can tell from the general conformation what type of labor she is likely to have. For example, a short, stubby fingered individual, with short femurs, will also have a contracted pelvis. The hormones developing at puberty have a marked effect in bringing about this change.

DR. MORTON (Closing).—I admit freely that the question of the sex differences is still a matter of controversy and certainly 27 pelves are not a sufficient number upon which to base definite conclusions. Fehling's study was based upon 130 fetal pelves and was very detailed and rather convincing. On the other hand, I should like to refer you to the recent study of Yamamura. This author reported an extremely detailed study of 140 fetal pelves, in which all the measurements and indices were handled statistically. While Yamamura seems to have accepted Fehling's general thesis, careful inspection of his figures reveals that there were numerous points of disagreement. Furthermore, Yamamura's figures revealed only one sexual difference which could be said to be statistically significant. The finding referred to was the closer proximity of the greatest transverse diameter of the inlet to the sacrum in the male. You will recall that our roentgenologic study of children's pelves showed a similar statistically significant difference. These facts may indicate that sex changes *do* start at a very young age. However, I do feel that the major changes appear at puberty and do not believe that the problem of whether there are any sex differences at all before this time can be settled until we have studied this question in more detail.

You are all probably familiar with the experimental work on the effects of hormones on the bony pelvis in animals. Hisaw working with the pocket gopher, and Corner with rats, demonstrated that in both castrate and noncastrate male animals the bony pelvis could be made to take on female characteristics by the administration of estrogenic substances. These results constitute rather convincing evidence of the effect of the sex hormones upon the growth and development of the pelvis.



## SOLUTION OF POSTERIOR PITUITARY SULFONATE (PIT-SULFONATE) IN LABOR\*

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**S**OLUTION of posterior pituitary U.S.P. when used before the end of the second stage of labor may cause tetanic contractions of the uterus with possible injury or death of the fetus or rupture of the uterus with possible death of the mother. In view of these dangers, obstetricians have refrained from the use of solution of posterior pituitary to hasten delivery. Some have used it to induce labor. Since the response of the uterus to the hormone is variable, the usual initial injection for inducing labor has been 0.03 c.c. (one-half minim) and every twenty minutes the dose has been increased by 0.03 c.c. to a maximum of 0.2 c.c. (three minims). As soon as the patient is having contractions of thirty seconds or more duration, at intervals of three to five minutes, its use has been discontinued. The total amount used is 1 c.c. This is obviously a time-consuming procedure but is a relatively safe method for preventing tetanic contractions of the uterus. However, one of us has seen 5 patients who had uterine ruptures from posterior pituitary solution. One patient had 0.3 c.c. and died, another had 0.12 and died, while of the others each had 0.12 c.c. and recovered.

Many patients are delivered by general practitioners who believe that they can hasten delivery by injecting solution of posterior pituitary, without any danger to the mother or baby. This procedure may be dangerous even when the cervix is completely dilated. In these cases the obstetrician believes that the delivery is effected with less danger by means of the forceps. The general practitioner has fairly valid reasons why he does not use the forceps; thus, many of his deliveries are at the home and he has either forgotten the forceps or they are not sterile, and he is alone.

Realizing these dangers from solution of posterior pituitary, several pharmaceutical houses combined the posterior pituitary hormone with other glandular extracts. Of these, the thymus was the one most frequently used. Injection of these combined pituitary and thymus extracts during labor were said to be without danger to mother or baby. DeLee recently stated that the consensus of opinion of obstetricians who have

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used these substances is that these solutions merely contained less of the posterior lobe hormone than the standard solution.

We believe that if the hormone from the posterior lobe of the pituitary could be combined with some other substance, so that it would be liberated very slowly, the dangers would be minimized or eliminated. We have found that the posterior pituitary principle can be precipitated from an aqueous solution with the aid of high molecular weight sulfonic acids. The best reagents appear to be the anthraquinone sulfonic acids or their amides and of these the anthraquinone 2.6 disulfonic acids appear to be the best. These combinations with the posterior pituitary hormone may be suspended in water or peanut oil and are quite suitable for use. This report deals with the product obtained by precipitating the posterior pituitary hormone with anthraquinone 2.6 disulfonic acid, and suspending the latter in a 0.5 per cent solution sodium-anthraquinone 2.6-disulfonic acid. The resultant product, solution of posterior pituitary sulfonate, which for the sake of brevity we have called pit-sulfonate, has an acid reaction. The posterior pituitary hormone is liberated when the solution becomes alkaline. This would happen immediately if the solution were injected intravenously. If injected subcutaneously or intramuscularly, the pituitary hormone is liberated slowly. There is a very small amount of the active hormone in solution and if large amounts of pit-sulfonate are injected, the free hormone will give the usual early pituitrin reaction, thus tending to mask the response of the new substance.

Experiments with pit-sulfonate on uterine strips showed no difference from solutions of posterior pituitary. Therefore, its oxytocic content is equal to that of the solution of posterior pituitary. Since the strips were immersed in a buffered solution and since the pituitary hormone is set free on neutralization, this result is what one would expect.

Experiments carried out at the Lilly Research Laboratories by Doctors Chen and Swanson yielded the following results:

Samples 124 and 125 of pit-sulfonate were tested for delayed anti-diuretic potency in rats by the Burn Method. The results are shown in Table I.

TABLE I

SUBSTANCE	NUMBER OF RATS	MEAN TOTAL AT MAXIMUM RATE C.C.	MEAN TOTAL AT END OF TEST C.C.	DURATION OF TEST MIN.
Standard lot of pituitary extract	12	14.05	27.5	192
124	12	14.56	28.0	189
125	12	14.10	28.6	183

As shown in Table I, all three tests are approximately the same. Thus, in comparison with the control, the medicated samples did not show a retention of urinary excretion. The antidiuretic value is the same as

the standard hormone. These results are what one would expect because to obtain the proper dose for the small animals the solution of pit-sulfonate had to be diluted five hundred times, thereby resulting in the immediate freeing of the pituitary hormone.

In intact anesthetized cats and guinea pigs, the results are shown in Table II.

TABLE II

SUBSTANCE	NUMBER OF TESTS	MEAN LATENT PERIOD MIN.	MEAN TIME TO PEAK EFFECT MIN.	MEAN TOTAL DURATION MIN.	MEAN LATENT PERIOD MIN.	MEAN TIME TO PEAK EFFECT MIN.	MEAN TOTAL DURATION MIN.
Standard lot of pituitary extract	3	5	80	373	3	20	60
124	3	4	60	400	2	12	48
125	3	4.5	60	347	3	17	52

With all three samples the rate of oxytocic and pressor action is about the same. Thus, in comparison with the control, the medicated samples show no delayed or prolonged action.

On the blood pressure of 12 anesthetized cockerels, intramuscular injection of the three samples failed to produce any change in the blood pressure. Intravenously, however, there was a characteristic decrease in blood pressure. As would be expected, by vein all three samples gave the same action without a difference in the duration of action.

The undiluted pit-sulfonate was used in the experiments for determining the oxytocic and pressor values in cats, guinea pigs, and cockerels. However, the doses varied from 0.2 to 0.3 c.c. per kilogram of cat and 0.5 to 1.5 c.c. per kilogram of guinea pig and cockerel. The oxytocic dose in the human ranges from 0.03 to 0.3 c.c. and the antidiuretic from 0.1 to 1.0 c.c. Comparable doses in a 60 kilogram woman would be 1.8 to 20.0 c.c. for the oxytocic and 6.0 to 60 c.c. for the antidiuretic. The comparatively huge doses used in the animals would contain enough free hormone to mask the action of the pit-sulfonate.

Studies on the human subject with the drug given intramuscularly or subcutaneously have shown striking differences from the solution of posterior pituitary. A patient with diabetes insipidus was given 0.5 c.c. doses every twelve hours of either posterior pituitary or pit-sulfonate with results as shown in Table III.

TABLE III

MEDICATION	INTAKE, C.C. - PER 24 HOURS - URINE, C.C.	
None	9,480	9,690
None	13,380	9,180
Posterior pituitary	3,240	1,740
Pit-sulfonate	2,100	600

Pit-sulfonate although of the same strength as the standard solution, had a more marked antidiuretic effect, because it was liberated slowly, thus prolonging its action.

Data from the same patient comparing identical doses of the standard and new product are illustrated in Fig. 1. As would be expected,

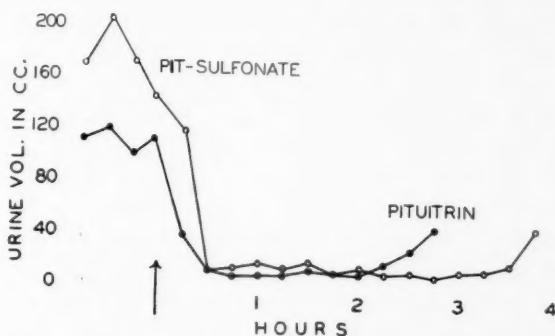


Fig. 1.—Graphs showing the antidiuretic effect of 0.06 c.c. of solution posterior pituitary and 0.06 c.c. of pit-sulfonate in a patient with diabetes insipidus. Two hundred cubic centimeters of water were taken every thirty minutes. The arrow indicates time of injection.

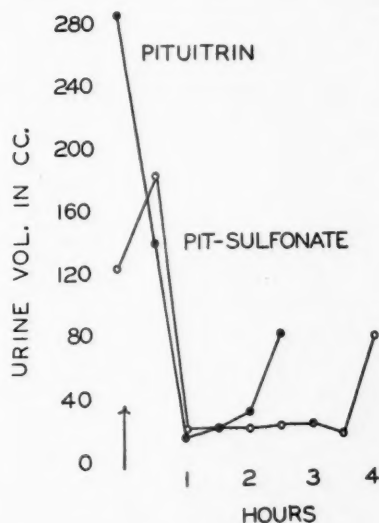


Fig. 2.—Graphs showing the antidiuretic effect of 0.06 c.c. of solution posterior pituitary and 0.06 c.c. of pit-sulfonate in a normal subject. One thousand cubic centimeters of water were taken one hour before the injection.

the solution of posterior pituitary caused a decrease in the urine output earlier than the pit-sulfonate. However, the latter compound had a much more prolonged action.

Similar amounts of pit-sulfonate and posterior pituitary were given subcutaneously to one of us (W. J. D.). The antidiuretic effect of the

new product does not manifest itself as early as the posterior pituitary. However, its action consistently lasts longer, as depicted in Fig. 2.

Fig. 3 illustrates the effect of posterior pituitary and pit-sulfonate on the same human pregnant uterus. The pressure changes were determined by an intrauterine bag. It is obvious that the posterior pituitary had a much shorter latent period and resulted in definite tetany.

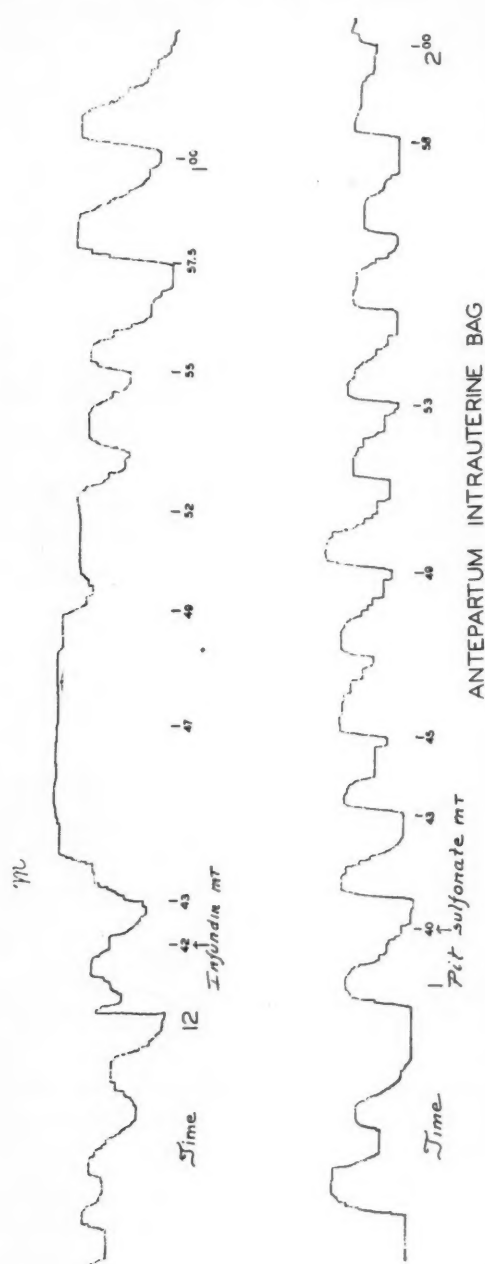


Fig. 3.—Recording of contractions of pregnant uterus. Posterior pituitary and pit-sulfonate were injected in the same patient.



The new product resulted in an increased tonus but there were always very definite contractions. Similar studies were made in 23 patients. The difficulty with this method of study lies in the fact that the susceptibility of the uterus to posterior pituitary parallels the time the bag is in the uterus. Thus, the latent period would be shorter and the contractions stronger at the end of four hours than at the end of one hour.

Numerous studies were made by Fenning, Associate Professor of Pharmacology and Physiology, University of Utah, with his capacigraph, an instrument which records uterine contractions, but has no connection with the patient. Sixty-five patients at term were given solutions of posterior pituitary or pit-sulfonate. Fig. 4 illustrates the effect of posterior pituitary solution and of pit-sulfonate. The uterine tetany and shorter latent period with pituitary are obvious. Fenning concluded that pit-sulfonate has a latency and overall action approximately two times that of solution of posterior pituitary.

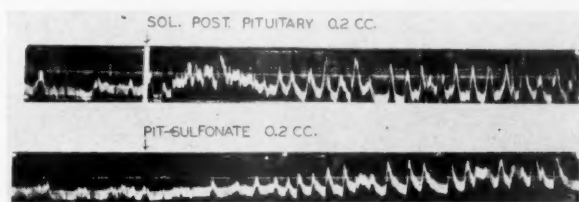


Fig. 4.—Capacigraph of Fenning. Contractions of pregnant uterus after injections of posterior pituitary and pit-sulfonate in different patients. Time interval is the same.

Studies with the Fenning hysterograph are shown in Fig. 5. Repeated 0.2 c.c. doses of pit-sulfonate resulted in an increased amplitude and frequency of the contractions without the development of uterine tetany in a patient who went on to delivery within three hours.

Fig. 6 illustrates the effect of pit-sulfonate on the post-partum uterus. Rhythmical uterine contractions began twenty-five minutes after the injection and were still present at the end of five hours. Posterior pituitary has a much shorter latent period.

This work was started in April, 1938, and our problem has been to determine if pit-sulfonate had any actions which were different from those of the solution of posterior pituitary on the human pregnant uterus. Careful observations were made on pregnant patients at term who were either having labor induced or were having very irregular contractions. The early studies were all made by one of us (W. J. D.). Subsequent observations were made by the residents and internes under supervision of one of us (W. J. D.).

We were interested in determining the following: (1) the latent period before a uterine contraction begins after the injection of posterior

pituitary or pit-sulfonate; (2) the duration of the first contraction; (3) the length of time over which these products were active; and (4) the fetal heart rate.

Data for the latent period are given in Table IV. The statistical analysis of the pit-sulfonate data are based on the latent periods from one to twenty minutes. The mean for solution of posterior pituitary is 5.2 minutes, while the mean for pit-sulfonate is 12.8 minutes. If the

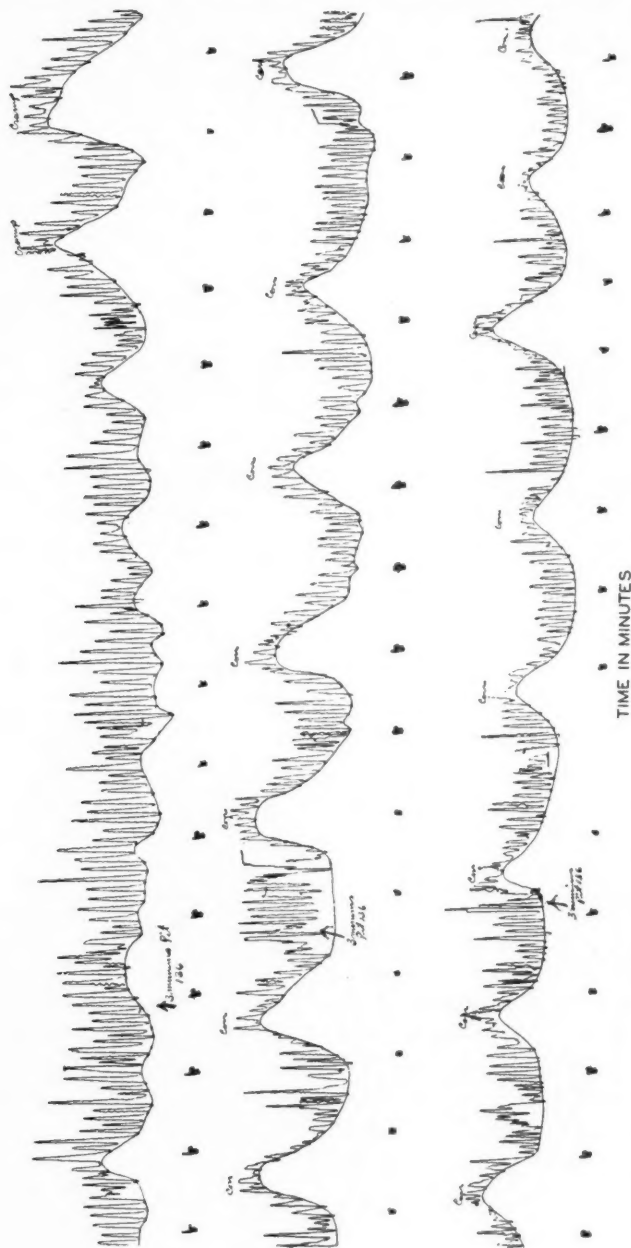


FIG. 5.—Hystero-graph of Fenning. Contractions of pregnant uterus after repeated injections of pit-sulfonate. The fine lines are due to maternal respiratory movements, and the course waves are caused by uterine contractions.

latent periods over twenty minutes were included, this figure would be larger. All of the latent periods for posterior pituitary were less than ten minutes and 88 per cent were less than seven minutes. Sixty-eight per cent of the latent periods for pit-sulfonate were over ten minutes and twelve per cent were over twenty minutes. It is apparent that there is a marked variation in the latent period but this is what one would expect since patients vary in their susceptibility to posterior

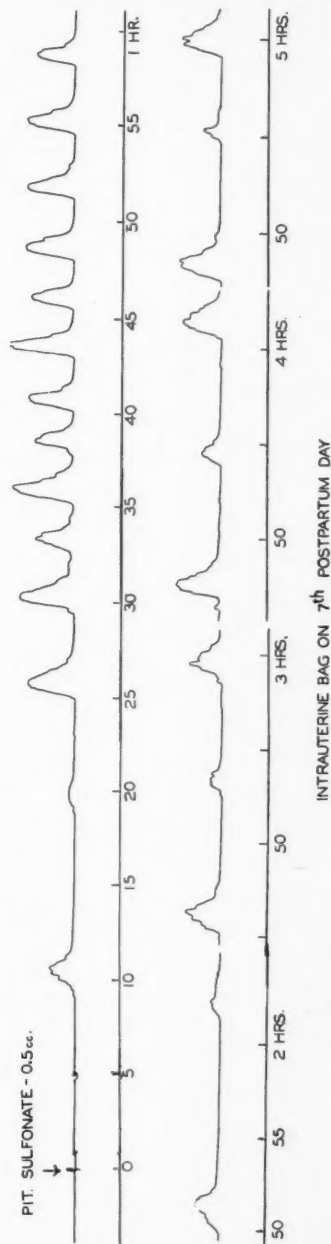


Fig. 6.—Recording of contractions after an injection of 0.5 c.c. of pit-sulfonate.

pituitary. The latent periods of two to six minutes with the pit-sulfonate are the result of the minute amount of the pituitary hormone which is in solution. In an endeavor to eliminate these early contractions studies of pit-sulfonate in oil are now in progress.

TABLE IV. LATENT PERIOD OF ANTE-PARTUM SUBCUTANEOUS INJECTIONS

LATENT PERIOD MINUTES	SOLUTION POSTERIOR PITUITARY	PIT-SULFONATE
1-2	2	1
3-4	10	9
5-6	11	17
7-8	2	14
9-10	1	38
11-12		54
13-14		24
15-16		22
17-18		14
19-20		21
21-26		11
27-32		9
33-60		11
Total cases	26	245
Mean	5.2 minutes	12.8
Standard error	0.34	0.31
Standard deviation	1.76	4.67

Certain patients showed increased uterine tonus but in over 245 patients with one to five injections each, none had uterine tetany to a degree that caused any concern about fetus or mother. The initial contractions lasted from ten seconds to one minute. One doctor on the courtesy staff stated that his patient had marked uterine tetany but there is no corroboration of his observation. On many patients treated by one of us (W. J. D.) each dose of pit-sulfonate was 0.3 c.c. (five minims) with no evidences of tetany. A similar amount of posterior pituitary solution almost invariably produces uterine tetany.

The duration of action was difficult to measure and could only be estimated. If we use posterior pituitary for the induction of labor, the injections are given every twenty minutes but with pit-sulfonate the intervals are usually forty to sixty minutes.

TABLE V. LATENT PERIOD OF ANTE-PARTUM SUBCUTANEOUS INJECTIONS IN SAME PATIENTS

NUMBER	POSTERIOR PITUITARY MINUTES	PIT-SULFONATE MINUTES	DOSE C.C.
204502	5	10	0.06
212400	2	8	0.06
206181	2	10	0.06
206181	3	7	0.2
215241	2	2	0.06
215241	1	3	0.06

The fetal heart rate might decrease twenty to thirty beats per minute if the initial contraction lasted one minute, but there was no evidence

at any time of fetal asphyxia. Recovery was always rapid and complete. Attempts were made to obtain graphic records of the fetal heart sounds but the changes in the abdominal contour during uterine contractions caused the microphone to move, producing so much noise that we were unable to obtain satisfactory records. Our studies are all based on periodic counts made by auscultation. The can of ether and mask are no longer kept at the patient's bedside during induction of labor with pit-sulfonate. There were no fetal deaths or injuries to fetus or mother.

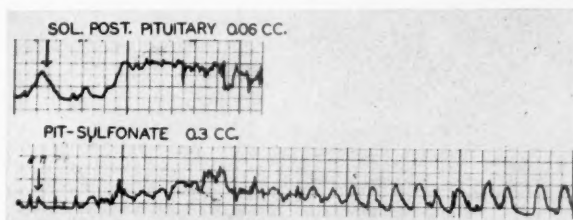


Fig. 7.—Tocograph of Lorand. Contractions of pregnant uterus after injection of 0.06 c.c. of posterior pituitary and 0.3 c.c. of pit-sulfonate in different patients. Time interval is the same. (Courtesy D. P. Murphy.)

Data in Table V illustrates a comparison of the two substances on the same patients. The difficulty here again lies in the fact that the uterus, as a rule, is more susceptible to the second injection than to the first. Therefore, three of these patients had posterior pituitary first and the other three had pit-sulfonate first. It is apparent that with but one exception, the latent period for the pit-sulfonate was much longer than that for posterior pituitary.

Dr. Albert Holman, who induces labor in many patients with posterior pituitary solution has used pit-sulfonate in over two hundred cases. The injections and observations were all made by one person who has been doing this work for years. Holman states that with posterior pituitary it required 8 to 12 doses at thirty-minute intervals to induce labor while with pit-sulfonate only 3 to 5 doses at sixty-minute intervals are required. The latent period for posterior pituitary according to him is two to four minutes while with pit-sulfonate the latent period is ten minutes with the maximum contraction occurring in about thirty minutes after the injection. He states that they observed no stormy or tetanic contractions of the uterus and that the contractions which occurred after pit-sulfonate simulated those of normal labor much more closely than those produced by solution of posterior pituitary.

Studies of the effect of pit-sulfonate on the post-partum uterus were made at the University of Michigan by Dr. S. Gardner. He states that the latent period is ten to twenty minutes. It produced large rhythmical contractions which lasted from fifty minutes to four hours and forty-five minutes. The action of the pit-sulfonate according to him was much longer than that obtained with solutions of posterior pituitary. He thinks it is similar in action to the oral or intramuscular action of the whole alkaloid of ergot or ergonovine.

Experiments with pit-sulfonate have also been carried out, using the Lorand tocograph at the University of Pennsylvania by Dr. D. Murphy.



Fig. 7 illustrates the tetany produced by posterior pituitary as compared with a larger amount of pit-sulfonate.

Observations by Murphy on M. B., a primipara, at term, 4 cm. dilatation, having irregular contractions were as shown in Table VI.

TABLE VI

LATENT PERIOD MINUTES	TIME MINUTES	
	0	0.2 c.c. pit-sulfonate
12	12	Uterine contractions and slight abdominal pain
	24	0.2 c.c. solution of posterior pituitary
5	29	Uterine contractions and abdominal pain
	31	0.3 c.c. pit-sulfonate
11	42	Uterine contractions and abdominal pain
	49	0.3 c.c. solution of posterior pituitary
6	55	Uterine contractions and abdominal pain
		Patient delivered 12 hours later

Doses of pit-sulfonate of 0.2 to 0.3 c.c. have been used during the second stage in six primiparas and fourteen multiparas. No tetanic contractions were produced and there were no significant alterations in the fetal heart rate.

We do not advocate any type of posterior pituitary hormone to hasten delivery, but we believe that we have accomplished our objective which was to produce a compound of the posterior pituitary hormone which could be used by the physician with much less danger to mother and fetus.

We have purposely omitted any data pertaining to the per cent of patients in whom labor was successfully induced because our only purpose was to prove that we had altered to some degree the properties of the solution of posterior pituitary U.S.P.

#### CONCLUSION

Subcutaneous or intramuscular injections in pregnant women at term of solution of posterior pituitary sulfonate differ from the usual solutions of the posterior pituitary hormone in that the latent period is longer, there is little, if any, likelihood of tetanic contractions of the uterus, and the duration of action is longer.

We are indebted to the following for pertinent data: Drs. K. Chen, E. Swanson, Con Fenning, S. Gardner, D. Murphy, and Albert Holman.

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#### DISCUSSION

DR. ALFRED C. BECK, BROOKLYN, N. Y.—My lack of experience with this particular preparation will not permit me to say anything either for or against it. A wide experience with the use of posterior pituitary extract, however, enables me

to discuss Dr. Dieckmann's paper and comment on his endeavor to diminish the risks associated with this powerful uterine stimulant.

We began to use posterior pituitary extract soon after it was introduced in this country. At that time it was given to almost every woman soon after the cervix was fully dilated. This use of the drug not only shortened the second stage of labor but it so reduced the need for forceps extractions that obstetric forceps were threatened with extinction. After several years, however, we began to attribute some of our fetal deaths to the use of this new drug. These bad results, together with the frequent reports of rupture of the uterus which appeared in the literature, led us to become more cautious and the use of posterior pituitary extract was restricted to those cases in which the requisites for forceps were fulfilled and an indication for forceps extraction had arisen. Thus because of an occasional bad result, an excellent addition to our armamentarium was almost abandoned.

Even when the drug was given in very small doses these dangers, as Dr. Dieckmann has noted, could not be eliminated. I recall one instance in which a multipara, who entered the hospital because she thought she was in labor, was given one minim of posterior pituitary extract to induce labor after a night's sleep. Within a few minutes the uterus began to contract violently. In spite of the fact that the patient was immediately anesthetized with chloroform, the fetal heart rate dropped to 80 and became irregular. Fortunately she delivered within twenty minutes and, although the child was deeply asphyxiated, it survived.

If one minim of the drug can cause such violent and prolonged contractions, the caution which we employed with regard to its use was certainly justified. On the other hand, were we justified in abandoning the use of this drug just because of the occasional difficulties which followed its use?

Dr. Dieckmann and his associates not only have not abandoned the use of posterior pituitary extract, but they have sought to lessen its dangers by altering its composition so that its absorption might be delayed. That they have been successful seems to be evident from the results of their investigations. That the delay in absorption will diminish the risk also seems to be evident from the results of its clinical application in a fair number of cases.

If further experience confirms these early observations, their work will restore to general usefulness a drug which once was considered a boon to obstetrics, and the elimination of its dangers not only will justify its use in the second stage but will make posterior pituitary extract invaluable in the treatment of the troublesome cases of first stage inertia.

DR. GEORGE KAMPERMAN, DETROIT, MICH.—The small amount of pit-sulfonate placed at our disposal by Dr. Dieckmann was of course not adequate for any conclusive observations. The five cases in which this drug was used were all cases of uterine inertia. In all these pains had lagged and although some dilatation had resulted, progress was exceedingly slow. However, enough dilatation was present to make a positive diagnosis that labor was actually in progress.

In these few cases the results as reported by the essayist were borne out. The latent period was longer than when pituitrin is used, approximately about twelve minutes passing before the change in pains was noted. This increase in pain was noted in 4 out of 5 cases. In no case was any tetanic contraction observed nor were contractions stimulated that caused a hasty or tumultuous termination of labor. The contractions seemed like normal uterine contractions and no fetal heart change was noted, and no baby was born with symptoms of distress.

We are in accord with the opinion that ecbolics are rarely necessary in normal labor, and should be used only when contractions are weak, and no obstruction exists. Never should they be used merely to hasten the termination of labor. But we do believe that a drug that could mildly stimulate uterine contractions without dis-

advantages would be a very useful addition to an obstetrician's equipment. And while we believe the abuse of ecbolics may do immense harm, we still feel there is a place for their careful and skillful use. A new preparation like pit-sulfonate will perhaps be safe only when used with the same caution and care that should be exercised when using pituitrin. The unhappy results of the abuse of pituitrin may protect the reputation of the newer preparations as they are developed.

DR. WILLIAM R. NICHOLSON, PHILADELPHIA, PA.—I have been greatly interested in this paper because I have always believed in pituitrin, as the last speaker said, if it is used in the right way. It has always seemed to me that one might just as well say that strychnine or morphia must not be used because fatal harm can be done with them in overdoses as to condemn pituitrin completely for obstetric use. I have yet to see a case in which there was a tetany of the uterus with the dose that I insist upon as an initial dose, that is, one minim. I have of course seen tetany of the uterus in the old days when so-called "surgical pituitrin" first came out which was double the strength of the present "obstetric pituitrin" and when the initial dose was larger.

I have probably used pituitrin a little more generally and with less strict indications than some of those who have spoken today. I have used it to stimulate sluggish contractions, even though the cervix was not more dilated than three or four fingers, but it was given only in small doses and at proper intervals.

DR. JOSEPH L. BAER, CHICAGO, ILL.—With complete deference to Dr. Nicholson, I must say that we have seen tetany of the uterus follow one minim of pituitrin and with death of the fetus in utero. Moreover, there is the risk that the nurse may misread the order and give an ampoule instead of a minim. That has happened, I confess with humility, in our institution. I hope that Dr. Dieckmann, if this product is to be put on the market, will see to it that it is put out in one minim doses per ampoule. I offer the suggestion to the pharmaceutical firms that they put out their pituitary drugs in two groups, 1 c.c. ampoules for hemorrhage only, and one minim in ampoules for induction of labor.

DR. DIECKMANN (closing).—We do not use pituitrin to hurry labor or delivery. I have used this drug on 6 primiparas and 14 multiparas with complete dilatation and the head on the floor. Most of these were private patients. There was no abnormal slowing of the fetal heart rate and no uterine tetany. I believe this drug will be of value to the obstetrician for the induction of labor. I do not believe the general practitioner should use any form of pituitrin to hurry delivery, but if he is going to use an oxytocic, I believe pit-sulfonate is less likely to cause damage to the mother or fetus than pituitrin. Before it is released, it will be given extensive trials by obstetricians.

## INTESTINAL INJURIES RESULTING FROM IRRADIATION TREATMENT OF UTERINE CARCINOMA\*

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*(From the Clinic of the Woman's Hospital)*

**M**OST of our knowledge and experience in the use of irradiation therapy for the treatment of uterine carcinoma has been acquired in the past twenty-five years. Within this time, reports from various excellent clinics throughout the world have appeared, describing a variety of techniques for radium and roentgen ray therapy and presenting statistical summaries of the results that have been obtained.

Although there is still some difference of opinion as to optimum amounts of irradiation to be used and the safest and most effective methods for its application, in general it may be stated that irradiation therapy for uterine carcinoma has become fairly well standardized.

Recognizing the value of this form of therapy and the risks involved in its use, gynecologists strive to meet two objectives, namely:

1. To deliver an amount of irradiation which can now be determined with reasonable accuracy as sufficient to destroy the malignant process provided it is radiosensitive and is confined to the uterus and its parametrial supporting structures.
2. To protect adjacent anatomic structures, and especially the urinary and intestinal tracts, against excessive secondary irradiation effects which may be destructive to their substance and function.

In reporting the results of therapy, it has been customary to record facts regarding the effect of irradiation on the progress of the disease and the survival rates of patients treated. Until recent years relatively little has been written regarding the undesirable and occasionally dangerous secondary effects of irradiation on the surrounding healthy tissues.

The few reports in medical literature regarding such complications have given detailed clinical and pathologic descriptions of some of the serious intestinal injuries that have been observed. They have also included discussions as to the probable causes of such injuries, but as a rule have provided little information as to the frequency of their occurrence.

However, in 1937, Corseaden, Kasabach and Lenz<sup>1</sup> reported an incidence of 8.7 per cent of intestinal injuries which occurred as a result

\*Read at the Sixty-Seventh Annual Meeting of the American Gynecological Society, Skytop Lodge, Pa., June 15 to 17, 1942.

of irradiation treatment of 442 patients for uterine carcinoma. The cases reported in this series included only the more serious injuries with symptoms requiring active treatment or surgical intervention. Reporting from England in 1938, Todd<sup>2</sup> stated that the incidence of irradiation intestinal complications following treatment of uterine carcinoma was approximately 5 per cent in all clinics. His statement was based upon his knowledge of the results of treatment at the Christie Hospital and Holt Radium Institute in Manchester, the Marie Curie Hospital in London and the Radiumhemmet in Stockholm. His statistics probably included only the more severe types of injuries. In 1941, Chydenius,<sup>3</sup> of Helsingfors, reported an incidence of 10.2 per cent of intestinal strictures that followed irradiation therapy for uterine carcinoma in a series of 321 cases treated from 1937 to 1940.

The purpose of this report is to record our experience in the diagnosis and treatment of intestinal irradiation injuries at the Woman's Hospital from 1937 to 1941, inclusive. This recent five-year period was selected because we believe that during this time, data were recorded that give us the true incidence of intestinal injuries which developed following the technique of irradiation therapy employed. It is within this time that members of our staff have become aware of the frequency of occurrence of these intestinal lesions and that they produce characteristic symptoms and physical findings by which they can be diagnosed.

Irradiation injuries usually manifest themselves with the onset of intestinal symptoms, such as abdominal pain, frequent bowel movements, rectal tenesmus, and passage of varying amounts of blood and mucus by rectum. In some cases, the initial symptoms are those of intestinal obstruction, that is, abdominal pain, anorexia, nausea, vomiting, and obstipation or obstipation alternating with diarrhea. When these symptoms appear, they may be due to a temporary partial intestinal obstruction caused by hyperemia, edema, and spasm of the bowel at the site of an intestinal ulcer or to a true organic stricture resulting from the formation and contraction of scar tissue as Nature attempts to heal the injured bowel. Symptoms of an intestinal injury may develop at any time from immediately following irradiation therapy to within several months or years later.

Diagnosis of an irradiation injury is made by various means, including direct inspection of rectal and sigmoidal lesions through a sigmoidoscope, roentgen studies of the bowel and microscopic studies of biopsy specimens or of tissue removed at operation or at autopsy. Repeated examinations over a considerable period of time may be necessary to establish the diagnosis of an intestinal irradiation injury in any case under observation. Without careful diagnostic studies, it is impossible to be certain that symptoms suggesting the development of such injuries are not due to functional bowel disturbances, indiscretions in diet, too much catharsis or possibly conditions resulting from the malignant processes for which treatments were given.



As a check on the extent of a malignant growth, irradiation therapy is preceded, in our clinic, by routine examinations of the lower bowel and urinary tract.

In Table I, it will be noted that:

1. 16.9 per cent, or approximately one out of every six patients treated for uterine carcinoma, developed some degree of proved injury to the intestine.

2. Only one intestinal injury occurred following treatment of 47 patients for carcinoma of the corpus uteri.

3. Of 142 patients treated for carcinoma of the cervix uteri, 31 developed postirradiation intestinal injuries including 23 intestinal strictures. In other words, an intestinal injury developed in one out of every 4 to 5 cases treated for carcinoma of the cervix, and one out of approximately every 6 patients treated had a postirradiation intestinal stricture.

TABLE I. TYPE AND INCIDENCE OF INTESTINAL IRRADIATION INJURIES THAT OCCURRED DURING TREATMENT OF 189 CASES OF UTERINE CARCINOMA AT THE WOMAN'S HOSPITAL FROM 1937 TO 1941, INCLUSIVE

DIAGNOSIS IN CASES TREATED	NO. OF CASES	INTESTINAL LESION RESULTING FROM INJURY			
		PROCTO-SIGMOIDITIS	ULCER WITHOUT STRICTURE	STRICTURE	TOTAL
Carcinoma of corpus	47	1	0	0	1
Carcinoma of cervix	142	5	3	23*	31
Total cases treated	189	6	3	23	32
Per cent of cases treated	100	3.17	1.58	12.16	16.9

\*Includes one carcinoma of cervix following supravaginal hysterectomy.

The incidence, 16.9 per cent, of intestinal irradiation injuries which occurred in patients treated in our cancer clinic appears to be relatively high. This is true because in this series, every case of proved injury has been reported regardless of the fact that some were extremely mild, giving rise to only transient symptoms. In previously published reports, statistical data have included only the severe types of injuries requiring active treatment or surgical intervention for relief of symptoms. Had it not been our policy to investigate all cases with postirradiation intestinal symptoms, some of the injuries reported in this series would undoubtedly have been missed.

TABLE II. SUMMARY OF DIAGNOSES AND DISTRIBUTION OF THE 38 CASES AS TO CELL TYPE (EWING)

DIAGNOSIS	NO. OF CASES	CELL TYPE (EWING)					
		1	1-2	2	2-3	3	4
Adenocarcinoma:							
Corpus	1					1	
Cervix	4			1		3	
Squamous cell							
Carcinoma:							
Cervix	33	2	5	22	1	2	1
Total	38	2	5	23	1	6	1

Within the five-year period covered by this report 6 patients in addition to the 32 listed in Table I came under treatment for intestinal strictures. As irradiation therapy for carcinoma of the cervix uteri had been carried out in all of these cases by members of our attending staff with the same techniques which are employed in our cancer clinic, it was decided to include them in the series of cases to be reported. By doing so the number of patients with intestinal irradiation injuries was increased to 38. Of the 38 cases, 29 had postirradiation intestinal strictures.

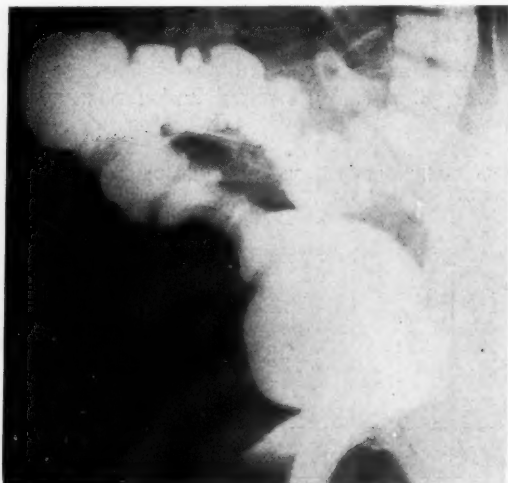


Fig. 1.—Mrs. S. (Hospital No. 74084), aged 35 years, was treated for adenocarcinoma of cervix with 4,200 mg. hr. of radium delivered in twenty-four hours. Intestinal symptoms began immediately after radium therapy. No roentgen therapy was used. Intestinal stricture was diagnosed at three weeks after radium treatment. Patient still has intestinal symptoms at one year and three months after irradiation therapy. *Comment:* Intestinal stricture was probably due to hyperemia, edema, and intestinal spasm at site of injury.

Table II is a summary of the diagnoses made in the 38 cases. It will be noted that the series included only one case of adenocarcinoma of the corpus uteri. Of the 37 patients with tumors of the cervix uteri, 4 cases were diagnosed as adenocarcinomas and 33 as squamous cell carcinomas. Table II also shows the distribution of the 38 cases of uterine carcinoma in accordance with the Ewing classification as to cell type.

Our own observations are in agreement with previously published reports<sup>1, 2, 4</sup> that intestinal complications resulting from irradiation injuries are due to three characteristic types or degrees of tissue reaction depending upon the location and extent of the original injuries. These include:

1. An acute localized proctitis or proctosigmoiditis.
2. Ulceration of the mucosa and wall of the intestine.
3. Formation of varying amounts of perirectal fibrous tissue.

Any one or a combination of these types of tissue reaction may develop in the same patient.

Acute proctosigmoiditis is the mildest form of intestinal injury observed as a result of the secondary effects of irradiation therapy for uterine carcinoma. Characteristic intestinal symptoms appearing during the course of treatment or soon after its completion give the first warning of the presence of such an injury. The symptoms include abdominal pain, diarrhea, rectal tenesmus, and the passage of small amounts of blood and mucus by rectum.



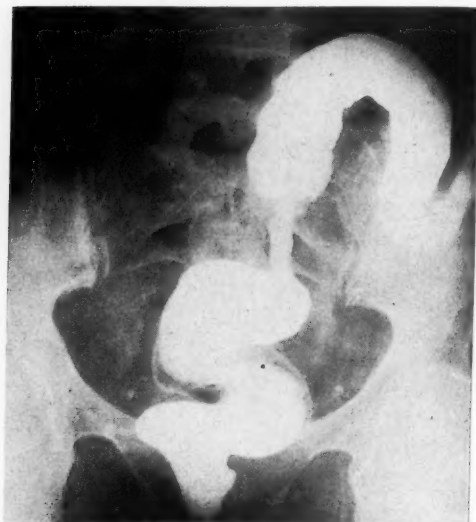
A.



B.

Fig. 2.—Mrs. E. (Hospital No. 75463), aged 59 years, was treated for adenocarcinoma of cervix with 4,200 mg. hr. of radium delivered in twenty-four hours and 8,000 r. of roentgen therapy in thirty-six days. Onset of symptoms and diagnosis of intestinal stricture, A, occurred at five months after irradiation. Patient was free of symptoms and roentgen examination, B, made thirty-nine days after Fig. 2, A showed much less constriction of the bowel at the site of injury. Sigmoidoscopic examination showed an increase in the size of the bowel lumen. *Comment:* Rapid improvement would suggest that hyperemia, edema, and spasm of the bowel were important factors in causation of the stricture seen in A.

Examination will reveal a typical localized inflammatory process involving the anterior wall of the rectum and distal end of the sigmoid



A.



B.

Fig. 3.—Mrs. J. (Hospital No. 68812), aged 51 years, was treated for squamous cell carcinoma of cervix with 4,800 mg. hr. of radium delivered in forty-eight hours and 8,800 r. of roentgen therapy in twenty-nine days. Intestinal symptoms began at four and one-half months after termination of irradiation. Diagnosis of intestinal stricture, A, was made one month later. Treatment was palliative. At two years and seven months after the diagnosis of intestinal stricture was made, the patient is free of intestinal symptoms, and roentgen study, B, shows the bowel to be practically normal in appearance. *Comment:* This is a good demonstration of Nature's success in healing such injuries.



A.



B.



C.

Fig. 4.—Mrs. M. (Hospital No. 60323), aged 56 years, was treated for adenocarcinoma of cervix with 4,800 mg. hr. of radium in thirty-six hours, and 8,800 r. of roentgen therapy in thirty-two days. Intestinal symptoms began two months after termination of irradiation therapy. Diagnosis of intestinal stricture, A, was made as soon as symptoms appeared. At four months after irradiation, symptoms were less troublesome although a roentgenogram, B, still showed definite constriction of the bowel at the site of the injury. Another roentgenogram, C, made four years after irradiation shows less constriction of the bowel. At this time the patient was symptom free, and has continued in good health up to now, over six years from time of irradiation therapy. *Comment:* This shows the success of palliative therapy and that bowel function may be normal although evidence of stricture persists.



at about the level of the cervix. The mucous membrane over the area is soft to palpation, intensely hyperemic in appearance or edematous with considerable mucous secretion over its surface. Trauma of the palpating finger or passage of a proctoscope readily induces slight bleeding. With a bland diet and suitable palliative treatment these mild injuries heal spontaneously and symptoms disappear soon after termination of irradiation therapy leaving no evidence of damage to the mucosa or wall of the intestine.

When injury to the bowel is more severe than that which causes an acute proctitis, ulceration of the intestine usually occurs. Although ulcerative lesions have been observed in both the rectum and sigmoid, the usual location for their development is on the anterior wall of the bowel at about the level of the cervix or at about 8 to 10 cm. from the anus.

Rectal examination will reveal an ulcer at least 1 to 2 cm. in diameter with a grayish white slough over its surface and an area of intense hyperemia and edema about its margin. Trauma of examination or evacuation of bowel contents readily induces bleeding. The extent of ulcerative lesions probably depends not only upon the severity of the original injuries but also upon secondary infection of the injured areas. In a small percentage of these cases, perforation of the bowel occurs into the peritoneal cavity, causing peritonitis; into the vagina, producing rectovaginal fistulas; or into the perirectal tissues, giving rise to ischiorectal abscesses requiring incision and drainage.

Ulcerative lesions make their appearance at any time from soon after termination of irradiation therapy to within several weeks or months later. They tend to heal slowly with separation of sloughs from their bases and inward growth of the surrounding healthy intestinal mucosa. When healing is complete the mucosa is pale and atrophic in appearance with some evidence of telangiectasis. Palpation of the lesion is likely to reveal some fixation as a result of the formation of fibrous tissue beneath the injured area. In some cases this increase in fibrous tissue extends into the wall of the intestine, constricting its lumen. Symptoms of a partial or complete organic obstruction may then appear.

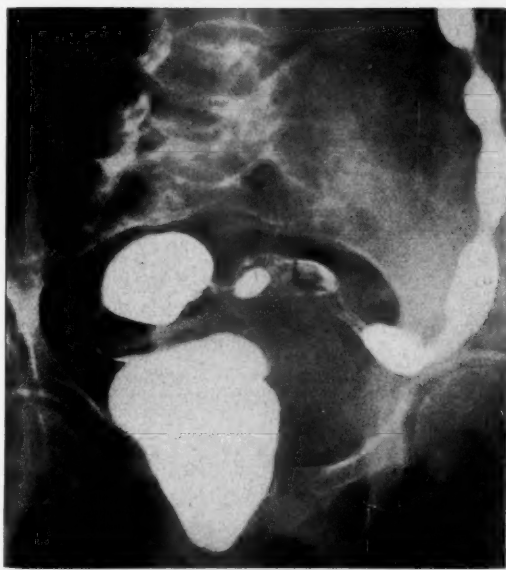
At the onset, symptoms caused by intestinal irradiation ulcers may be the same as those resulting from irradiation proctitis but are likely to be more severe. In many of the cases in our series, the initial symptoms were those of partial intestinal obstruction due to a reduction in size of the bowel lumen as a result of hyperemia, edema and spasm of the intestinal wall at the site of an ulcerative lesion.

Injuries resulting in acute proctitis and ulcerative lesions appear to be confined essentially to the mucosa and wall of the intestine itself and have been referred to as "intrinsic lesions."<sup>2</sup> There are a few other cases in which the primary injury appears to have involved the perirectal tissues. The characteristic tissue reaction following such injuries is the formation of a diffuse mass of fibrous tissue involving all the

pelvic structures below the uterocervical junction and extending upward and backward to the second or third sacral vertebra. This type of tissue reaction to irradiation referred to as an "extrinsic lesion"<sup>2</sup> produces a pelvic condition which is difficult to differentiate from the so-



A.



B.

Fig. 5.—Mrs. M. (Hospital No. 74794), aged 52 years, was treated for squamous cell carcinoma of cervix with 4,200 mg. hr. of radium delivered in twenty-four hours, and 8,000 r. of roentgen therapy in fifty-one days. Intestinal symptoms began immediately following irradiation and the diagnosis of intestinal stricture, A, was made at three months from termination of irradiation. Pelvic examination showed a "frozen pelvis" from the so-called "extrinsic"<sup>2</sup> type of injury. This is probably responsible for the distorted appearance of the lower bowel. A roentgenogram, B, made seven months later shows considerable improvement in the strictured bowel. At one year and nine months from the time the diagnosis was made the patient still has intestinal symptoms but is much improved. *Comment:* This is a good example of disturbance in bowel function from an "extrinsic" irradiation injury which has been treated by palliative means.

called "frozen pelvis" caused by massive invasion of all pelvic structures by malignancy. It may be associated with an ulcerative lesion of the bowel. As healing of this type of injury progresses, the lower bowel is likely to be distorted by contraction of the fibrous tissue and by external pressure causing intestinal obstruction.

Roentgen studies of the bowel are essential for diagnosis and proper management of many intestinal irradiation injuries. Some injuries resulting in strictures of the bowel occur at levels which do not permit satisfactory examinations through a sigmoidoscope. In others narrowing of the bowel lumen at the site of an injury prevents passage of a



Fig. 6.—Mrs. T. (Hospital No. 70965), aged 63 years, was treated for squamous cell carcinoma of cervix with 6,000 mg. hr. of radium delivered in forty-eight hours, and roentgen therapy 8,400 r. in thirty-eight days. Onset of symptoms and diagnosis of intestinal stricture, occurred at two months after termination of irradiation therapy. Pelvic examination at operation, one week after diagnosis was made, showed the sigmoid markedly thickened for a distance of 10 cm. and adherent to the uterus. A loop of ileum was fixed by adhesions to the peritoneum of the cul-de-sac and was thickened for a distance of 12 cm. Its lumen was slightly constricted. Nonviable cancer cells were found in tissue removed from the surface of the ileum at its point of attachment in the cul-de-sac. The surgical procedure adopted was Mikulicz colostomy. This patient died three months after operation from generalized carcinomatosis. *Comment:* This case shows the risk of bowel injury to adherent loops of intestine. Diagnosis of bowel stricture caused by irradiation was confirmed by operative findings. Operation was necessary one week after patient came under observation for bowel symptoms.

sigmoidoscope to a point at which the lesion can be satisfactorily visualized. By roentgen studies the existence and location of intestinal strictures can be determined and the success of palliative therapy can be checked. The decision as to whether palliative therapy should be continued or surgical intervention is necessary is usually based on physical symptoms and the results of such studies.

Figs. 1 to 8 show typical roentgen findings in some of the cases included in this series.

All of the 38 cases in the series that developed intestinal irradiation injuries had treatment with radium, and 27 of the 38 cases had additional roentgen therapy. In 19 of the cases, radium treatment was given



A.



B.

Fig. 7.—Mrs. W. (Hospital No. 74210), aged 40 years, was treated for squamous cell carcinoma of cervix with 4,200 mg. hr. of radium delivered in twenty-four hours, and 7,600 r. of roentgen therapy in thirty-six days. Intestinal symptoms began immediately following irradiation and intestinal stricture, A, was diagnosed at six months after termination of irradiation. Palliative treatment failed and a diagnosis of complete intestinal obstruction, B, was made five months later. At operation no evidence of malignancy was found in the abdomen or pelvis. The wall of the recto-sigmoid was markedly thickened for a distance of 10 cm. extending down to the floor of the cul-de-sac. The wall of the bowel was ulcerated and necrotic, and an impending perforation was sealed off by an adherent loop of ileum. The operative procedure adopted was permanent colostomy and abdominoperineal resection, removing the rectum and the damaged portion of the sigmoid. This patient is alive and well at seven months after operation. *Comment:* Timely operative interference is a life-saving measure for some patients who develop postirradiation intestinal injuries.

in one application and in the remaining 19 cases two applications were used. Roentgen therapy preceded treatment with radium in only one case.

Table V is a summary of the irradiation treatment and outcome of 9 cases in which intestinal injuries occurred without evidence of subsequent stricture. In 6 of the 9 cases, a diagnosis of proctosigmoiditis was made, and in 3 cases ulceration of the bowel also occurred at the site of the injury. In one case the ulcer perforated the rectovaginal septum, causing a rectovaginal fistula which healed spontaneously after two months. It will be noted in Table V that:

1. Onset of intestinal symptoms was from immediately following radium therapy in 5 cases to one year in one of the ulcer cases.
2. Diagnosis of an intestinal lesion was made in from one week to fourteen months after irradiation therapy.
3. Healing of the intestinal injuries was spontaneous in all of the 9 cases including the one with rectovaginal fistula and the two that died. At time of death these two patients had no intestinal symptoms.



Fig. 8.—Mrs. L. (Hospital No. 55947), aged 45 years, was treated for squamous cell carcinoma of cervix with 6,000 mg. hr. of radium in forty-eight hours. No roentgen therapy was used. Intestinal symptoms began at three months after irradiation therapy, but a diagnosis of intestinal stricture was not made until five and one-half years after she was treated. This patient was operated upon eight months after the diagnosis of intestinal stricture was made. At operation the mid-portion of the sigmoid was found adherent to the uterus and left uterine adnexa. The wall of the sigmoid was thickened for a distance of 10 cm. It was inflamed, necrotic, and perforated at the point of its attachment to the uterus. The operative procedure was resection of the damaged portion of the sigmoid by the Gibson-Balfour technique, and colostomy. This patient died one year and five months after operation from generalized carcinomatosis. *Comment:* The possibility of the development of intestinal obstruction from an irradiation injury at any time following treatment of uterine carcinoma must always be kept in mind.

In the series of 38 cases of irradiation injuries, 29 had intestinal strictures as proved by roentgen studies of the injured bowel. In 18 of the 29 cases with strictures, symptoms have been relieved or controlled by palliative means. The results of treatment of these cases are summarized in Table VI.



TABLE III A. SUMMARY OF RADIUM DOSAGE USED IN 19 CASES WITH INTESTINAL INJURIES FOLLOWING ONE APPLICATION OF RADIUM FOR CARCINOMA OF THE UTERUS

*Carcinoma of Corpus Uteri*, 1 Case. Radium dosage in the one case was 2,400 mg. hr. given in one application to the uterine cavity in 24 hours.

*Carcinoma of Cervix Uteri*, 18 Cases. In the 18 cases one application of radium was used as follows:

LOCATION OF APPLICATORS	DOSE IN MILLIGRAM HOURS				CASES TREATED
	2,000 IN 24 HR.	2,400 IN 24 HR.	3,000 IN 30 HR.	600-1,800 IN 24 HR.	
Cervical canal	1	16	1		18
Cervix (vaginal surface)		1			1
Parametrium (radium needles)				18	18

Range of total dosage in the 18 cases was from 3,000 to 4,500 mg. hr. in 17 cases and 6,000 mg. hr. in one case.

17 of the 19 cases in this group had additional *roentgen therapy* ranging from 7,600 to 10,000 r. within 26 to 51 days.

TABLE III B. SUMMARY OF RADIUM DOSAGE USED IN 19 CASES WITH INTESTINAL INJURIES FOLLOWING TWO APPLICATIONS OF RADIUM FOR CARCINOMA OF THE CERVIX UTERI

LOCATION OF APPLICATORS	FIRST APPLICATION			SECOND APPLICATION			
	DOSE IN MILLIGRAM HOURS			DOSE IN MILLIGRAM HOURS			
	1,200 IN 24 HR.	2,400 IN 24 HR.	600 TO 1,800 IN 24 HR.	1,500 IN 15 HR.	1,200 IN 24 HR.	2,400 IN 24 HR.	1,500 TO 1,800 IN 24 HR.
Cervical canal		18		1		2	
Cervix and uterine cavity	1						
Parametria (radium needles)			18		1		
Vaginal fornices (Clark colpostat)							16

Range of total dosage in the 19 cases was from 4,800 to 6,000 milligram hours. Total duration of radium exposure was 39 hours in one case and 48 hours in 18 cases.

10 cases in this group had *roentgen therapy* ranging from 6,000 to 10,000 r. within 22 to 50 days.

TABLE IV. SUMMARY OF WOMAN'S HOSPITAL ROENTGEN THERAPY TECHNIQUE USED IN CASES OF CARCINOMA OF CERVIX UTERI

Voltage: 200,000 (peak)	Distance: 70 cm.
Filtration:	Intensity:
(a) .75 mm. copper. 2 mm. aluminum.	(a) 25 r. per minute.
(b) .4 mm. tin. .25 mm. copper.	(b) 10 r. per minute.
1.0 mm. aluminum.	
Number of fields: 4-6.	
Size of fields: Maximum 16 x 12 cm.; average 16 x 10 cm.	
Centering of fields: Over parametria with protection of an area along the mid-line—2 to 3 cm. in width.	
Daily dose: 150-200 r. to each of two fields.	
150 r. per field routinely since 1938.	
Total amount administered to pelvis (measured in air): 8,000-10,000 r.	
Duration of cycle: 23 to 42 days (present minimum 30 days).	

From Table VI, it will be noted that in from three months to over six years of observation, 13 of the 18 patients had become symptom free, 2 were improved, 1 was unimproved, and 3 died of generalized carcinomatosis.

It is frequently difficult to differentiate between intestinal obstruction caused by tissue reaction to irradiation injury and conditions resulting from malignancy. The diagnosis of an irradiation intestinal stricture in any patient under observation is based upon improvement in general health following treatment, relief of intestinal symptoms following palliative treatment and roentgen evidence of increasing size of the lumen of the bowel at the site of injury.

Table VII is a summary of facts regarding irradiation therapy and diagnosis in 11 of the 29 cases of intestinal stricture which required surgical intervention for relief of symptoms. In this table it will be noted that:

1. Diagnosis of stricture requiring operation was made in from two months to five years and five months after termination of irradiation therapy.
2. Location of the stricture was in the rectum in one case, in the sigmoid in six cases, in the rectosigmoid in three cases and in the ileum in one case. In one case of sigmoid injury the ileum was also involved.

Table VIII is a summary of the surgical techniques used and outcome of the 11 cases of intestinal stricture that were operated upon for relief of symptoms.

Surgical indications which arise in the treatment of these cases include procedures to:

1. Relieve pain, bleeding and partial or complete intestinal obstruction.
2. Remove necrotic bowel which may perforate resulting in death from peritonitis.
3. Promote healing of ulcerative lesions by diverting the fecal stream. In some cases this can be accomplished by colostomy which can be closed after the intestinal injury has healed.

Success in the treatment of irradiation intestinal injuries requires the skill and judgment of an experienced surgeon. He must have the ability to select the surgical procedure best suited for treatment of injuries which vary considerably as to their extent and location.

Surgical treatment of such injuries is not infrequently complicated by the fact that they occur in patients who are either poor surgical risks or are in poor physical condition when operative interference becomes necessary.

Another factor which must be taken into consideration is the disturbance in circulation which occurs in tissues which have been subjected to intensive irradiation. With this in mind colostomy may be the primary procedure of choice to avoid complications arising from failure of wound healing following intestinal resection and anastomosis.

TABLE V. SUMMARY OF DATA REGARDING 9 CASES WITH INTESTINAL INJURY WITHOUT EVIDENCE OF STRICTURE

DIAGNOSIS	CASE	AGE	STAGE OF DISEASE		IRRADIATION				TIME FROM TERMINATION OF IRRADIATION TO:				TIME FROM DIAGNOSIS TO PRESENT		PRESENT CONDITION
					RADIUM		ROENTGEN RAY		ONSET OF SYMPTOMS	DIAGNOSIS TO:		PRESENT			
			LEAGUE OF NATIONS	SCHMITZ	DOSE MG. HR.	TIME HR.	DOSE R.	TREATMENT DAYS		MO.	WK.	YR.	MO.		
Proctosigmoiditis	1	51	-	-	2,400	24	7,800	26	Immediate		1	1	2	2	Symptom free
	2	54	2	3	3,500	20	3,200	10	Immediate	1	1	1	4	8	Symptom free
	3	52	1	2	3,600	24	8,000	40	Immediate					7	Symptom free
	4	57	2	3	6,000	24	None	-	Immediate	10			-	-	Dead. Cardiovascular disease after 4 years
Ulcer	5	46	2	3	6,000	48	7,200	29	Immediate			4	-	-	Dead. Carcinoma metastasis after 1 year
	6	30	2	3	6,000	48	8,000	50	Immediate	3	2		4	7	Symptom free
	7	41	1	2	4,200	24	8,400	33	Immediate		1		1	4	Symptom free
	8	58	2	3	4,500	30	10,000	32	12 mo.	14		3	3	10	Symptom free
	9	66	2	3	5,400	48	8,000	23	6 mo. R. V. fistula	6		2	2	5	Rectovaginal fistula healed after 2 months

Dignosis: Case 1, carcinoma corpus uteri, all others carcinoma cervix uteri.

In Case 2, roentgen therapy was discontinued on account of intestinal symptoms.

In Cases 1, 2, 3, 5, and 7, intestinal symptoms began immediately after radium.

TABLE VI. SUMMARY OF DATA REGARDING 18 CASES WITH INTESTINAL IRRADIATION STRICTURES IN WHICH RELIEF OF SYMPTOMS FOLLOWED PALLIATIVE TREATMENT

AGE	STAGE OF DISEASE		IRRADIATION				TIME, END OF IRRAD. TO ROENT. DIAG. OF STRICTURE			TIME, DIAGNOSIS OF STRICTURE TO PRESENT AND PRESENT CONDITION				
			RADIUM		ROENTGEN		YR.	MO.	DAYS	YR.	MO.	TIME	SYMP-TOM FREE	OUTCOME OF OTHERS
	LEAGUE OF NATIONS	SCHMITZ	DOSE MG. HR.	TIME HR.	DOSE R.	TIME DAYS								
50	1	2	3,000	33	8,000	33	1	6			6	2	x	
50	2	3	3,600	34	8,400	34	5				4	1	x	
33	2	3	4,200	24	8,000	26		6			1	2	x	
52	2	3	4,200	24	8,000	51		4			9			Improved. Bowel less constricted
35	2	3	4,200	24	None	-			10		2	1		Unimproved. Symptoms persist
40	1	2	4,200	24	8,000	24		4			2	4		
59	1	2	4,200	24	8,000	36		5			3	3	x	
32	2	3	4,200	24	8,000	40		5			-		x	Dead. 1 yr. 5 mo. Carcinoma metastasis
38	2	3	4,200	24	10,000	35		5			8		x	
51	1	2	4,800	48	8,800	29		5			5	2	x	
56	1	1	4,800	36	8,800	32		2			3	6	x	
63	3	3	6,000	48	10,000	35		6	15		1	3		Improved. Bowel less constricted
44	2	3	6,000	48	8,800	31		5	15		3	2	x	
44	2	3	6,000	48	8,000	28		3			6	2	x	
50	1	2	6,000	48	6,000	22	2				-	2	x	
38	1	2	6,000	48	None	-		5			-		x	Dead. 1 yr. 10 mo. Carcinoma metastasis
43	1	2	6,000	48	None	-		1			-		x	Dead. 2 yr. 3 mo. Carcinoma metastasis
35	2	3	6,000	48	7,700	33		9					x	





TABLE VIII. SUMMARY OF FINDINGS, SURGICAL TECHNIQUES EMPLOYED AND OUTCOME OF 11 CASES OPERATED UPON FOR INTESTINAL STRICTURES

LOCATION OF STRICTURE	OPERATION	POSTOPERATIVE FOLLOW-UP				
		ALIVE AND WELL	TIME SINCE OPERATION		DIED	TIME FROM OPERATION TO DEATH
			YR.	MO.		
Sigmoid	Partial resection sigmoid (Gibson-Balfour)	+	3	10		
Sigmoid	Partial resection sigmoid (Gibson-Balfour)	+	3	7		
Sigmoid	Partial resection sigmoid. Colostomy				+	17 months
Recto-sigmoid	Abdominoperineal resection sigmoid and rectum. Colostomy	+		7		
Ileum	Resection of 25 cm. ileum				+	4 days
Sigmoid	Colostomy (Mikulicz)				+	3 days
Recto-sigmoid	Colostomy (Mikulicz)	+	2	1		
Sigmoid	Colostomy (Mikulicz)				+	5 weeks
Sigmoid	Colostomy (Mikulicz)				+	3 months
Ileum	Adherent ileum Released		.			
Rectum	Colostomy (Devine)				+	3 months
Sigmoid	Cecostomy				+	46 days
						Generalized carcinomatosis
						Peritonitis
						Peritonitis
						Intestinal hemorrhage
						Generalized carcinomatosis
						Intestinal hemorrhage
						Necrosis of sigmoid. Small bowel obstruction. Pneumonia. Autopsy

In cases in which intestinal injuries have occurred as a result of irradiation treatments for uterine carcinoma, it is often impossible to determine whether they have been caused by radium or roentgen ray therapy. However, it is generally agreed that they are invariably due to overdosage of irradiation and that the primary injury is to the blood vessels which supply the injured bowel.<sup>2</sup> It is believed that damage to some of the smaller branches of the hemorrhoidal vessels results in their becoming thrombosed and occluded. This leads to infarction and mucosal ulceration in the portion of the bowel from which the blood supply has been withdrawn. There is reason to believe that muscular spasm of the bowel wall at the site of the injury may be another factor in decreasing its blood supply.

From the study of specimens in our own laboratory, it appears that the blood supply to the injured bowel is gradually rather than suddenly withdrawn. The basis for this conclusion is that within the areas of tissue necrosis observed, foci of reparative (inflammatory) tissue reaction can be identified. It is assumed that the cellular elements for this defensive tissue reaction must have been supplied by blood vessels which had not lost their function.

Figs. 9, 10, and 11 are drawings made from fresh surgical specimens.

A reduction in the incidence of these serious intestinal complications of irradiation therapy for uterine carcinoma must depend upon a better understanding of their etiology, recognition of the fact that they may make their appearance at any time from immediately following irradiation therapy to within several years thereafter, and elimination of conditions which are known to predispose to their occurrence.



Fig. 9.—Showing the characteristic external appearance of the bowel which has been injured by irradiation. The wall is thickened and has the consistency of a thick-walled "rubber tube." In the midportion of this specimen, there is a constricted, necrotic area, S. The dark color is due to extravasation of blood beneath the peritoneum.

Both clinical and experimental studies have contributed to our knowledge of factors which may be responsible for such injuries. The unusual susceptibility of the intestinal mucosa to damage from irradiation has been well established.<sup>1</sup> Overdosage of irradiation, which may be a frequent cause of such injuries, is undoubtedly the result of faulty technique or of conditions which are difficult to control. Cases have been reported in which intestinal injuries were due to accidental dislodgement of radium applicators from the cervical canal or uterine cavity to the vagina.

Other conditions which may result in excessive exposure of the intestine to radium include: a retroverted uterus, a uterus with a thin muscular wall and peritoneal adhesions which fix one or more loops of the intestine to the external surface of the uterus, or to the cervical stump following supravaginal hysterectomy. Furthermore, Todd has called attention to the fact that "the question of overdosage is a rela-

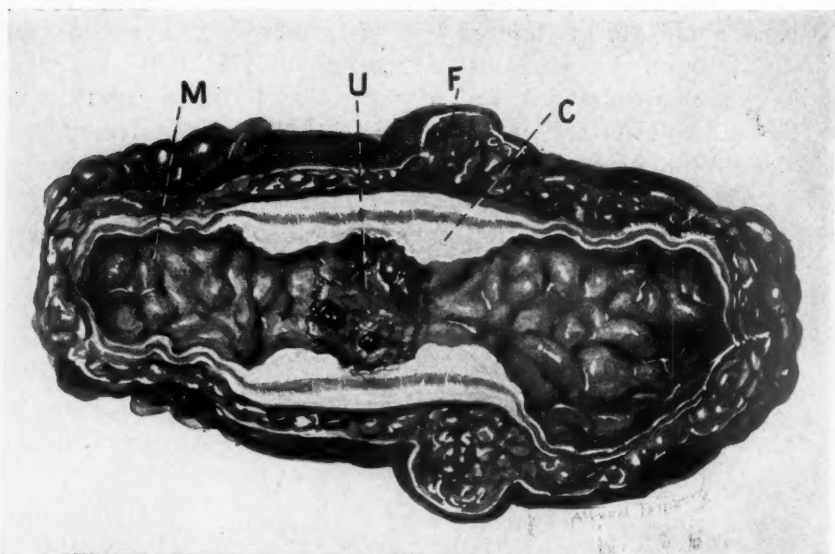


Fig. 10.—Showing a longitudinal section of this same specimen of bowel. The peritoneum and subperitoneal tissues, *F*, are markedly edematous. A typical mucosal ulcer, *U*, can be seen. Induration of the wall extends far beyond the limits of the ulcer. Nature's attempt to heal the injury has resulted in a marked formation of fibrous tissue, *C*, which has narrowed the lumen of the bowel.

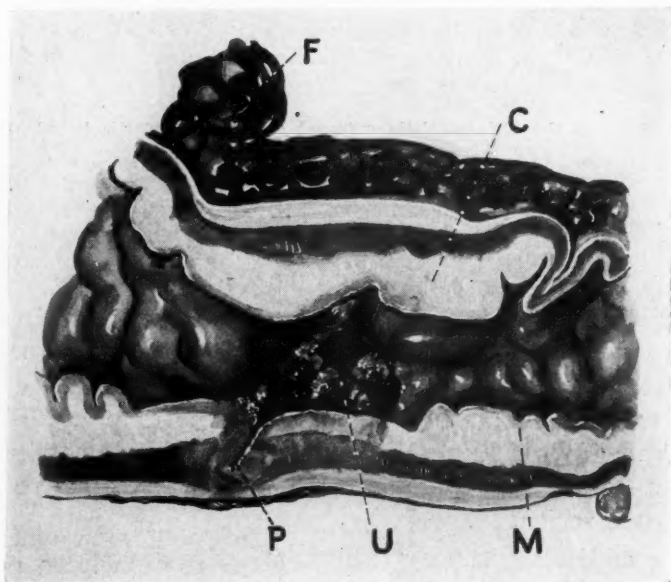


Fig. 11.—Longitudinal section of the same specimen but in a different plane. This shows the same characteristic anatomic changes seen in Fig. 10. In addition it has been made at a point at which the mucosal ulcer, *U*, has nearly perforated the intestinal wall at *P*.

tive one." In other words, tissue tolerance to irradiation may be reduced by poor general health and tissue changes resulting from degenerative diseases.

In some cases overdosage is undoubtedly due to the combined effects of radium and roentgen ray irradiation. Danger from this source can be reduced if roentgen exposure is carefully focused on the lateral pelvic structures and adjacent gland-bearing areas.

Numerous suggestions have been made to prevent irradiation intestinal injuries. They include:

1. Procedures to prevent accidental dislodgement of radium applicators from the cervical canal and uterine cavity.
2. Distention of the vagina with gauze and insertion of a rectal tube during application of radium with the purpose of increasing the distance between the radium and walls of the rectum and sigmoid.
3. Caution in the use of irradiation for treatment of patients who have had pelvic infections or previous abdominal or pelvic operations.
4. Frequent changes in position of a patient during radium treatment with the hope of dislodging intestinal loops which may be in close proximity to the uterus.
5. Roentgen studies of the intestine before placing radium in the cervical canal or uterine cavity to determine whether loops of intestine are fixed to the uterus or cervical stump by adhesions. Evidence produced by such studies is not always conclusive.
6. Preirradiation exploratory laparotomy to determine whether loops of intestine are adherent in positions that might subject them to too much irradiation. This seems a radical procedure and does not eliminate the possibility of intestinal adhesions re-forming immediately after the exploratory operation.
7. Reduction of intensity of irradiation by:
  - a. Using smaller amounts of radium and increasing duration of exposures.
  - b. Decreasing the size of the fields of roentgen ray exposures and the amounts of roentgen therapy per treatment.

#### CONCLUSIONS

1. Sufficient irradiation to effect a cure of uterine carcinoma cannot be applied without some damage to the intestinal tracts of a considerable percentage of patients treated.
2. The true incidence of such injuries cannot be determined without routine diagnostic studies of the intestinal tracts of all patients who develop significant postirradiation intestinal symptoms.
3. The development of intestinal symptoms and especially those of intestinal obstruction at any time from a few weeks to several years after irradiation for uterine carcinoma should always suggest the possibility of a post-irradiation intestinal injury.
4. Careful diagnostic studies will serve to differentiate intestinal irradiation injuries from reactivations or extensions of malignant growths and may be the means of saving lives.

5. Success in the treatment of intestinal irradiation injuries will depend upon a knowledge of the possibility of their occurrence, early diagnosis, suitable palliative treatment and, when indicated, timely operative interference.

I wish to acknowledge my indebtedness to Dr. William Crawford White, Consultant in Surgery, Dr. John E. Hutton, Gastroenterologist, and Dr. Harriett McIntosh, Roentgenologist, all of the Woman's Hospital, for their kind assistance in the diagnosis and treatment of the cases that have been reported. Their enthusiasm has done much to arouse the interest of our staff in this important subject.

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#### DISCUSSION

DR. JOE V. MEIGS, BOSTON, MASS. (by invitation).—There is apparently an increase in the number of bowel injuries following treatment of cervical cancer with x-ray and radium. It is possible in the past that such patients, treated with radium alone, went to other clinics and were not recorded, while others have had tenesmus, pain, and diarrhea but have recovered without treatment. It is more likely that the addition of roentgen therapy to the usual radium treatment has been an equal contributor to bowel stricture. Before the advent of deep roentgen therapy, an occasional case of obstruction was seen but recently more patients have come with serious lesions.

At the Massachusetts General Hospital and the Pondville Hospital we have had 30 such patients, or 3.6 per cent out of a total of 800 who were given x-ray treatment plus radium. In four other cases strictures followed radium alone. A great many other patients with symptoms of bleeding, tenesmus, pain, etc., were seen but are not reported here as this discussion deals only with actual bowel strictures as demonstrated by proctoscopy, x-ray, or operation.

The mortality following the treatment of the obstruction is low, nevertheless radiation stricture is a trying and difficult complication. About 100 of our 800 cases had supervoltage or 1,000—1,200 kv. therapy. Of these 100, 8 patients developed obstructing lesions. Twenty of the total of 30 followed 200 kv. therapy and 2 followed 400 kv. treatment. It is very probable that more cases will follow the million volt therapy until the proper dosage has been learned from a large experience.

Of the 34 patients with obstruction and stricture at the Massachusetts General Hospital and Pondville Hospital, 22 were operated upon. In the 12 patients not operated upon and diagnosed by x-ray and proctoscopy, 6 had lesions in the rectum and 6 in the sigmoid. The symptoms in all cases consisted of pain, rectal bleeding, nausea, vomiting, distention, and tenesmus. Of those operated upon, 11 had a colostomy done; 1 a colostomy with posterior excision of the rectum; 2 had ileotransverse colostomies plus resection of the ileum with sigmoid colostomy; 2 had ileotransverse colostomies plus resection of the ileum; 2 had ileostomies; 2 had resection of the ileum; in 1 a piece of adherent ileum was released; and in 1 an entero-enterostomy was done.

There was only 1 postoperative death, but of the 22 patients operated upon, 4 have since died. The average time to the onset of bowel symptoms from the time



of treatment was one month to twelve months in 17 cases, with an average of six months; in 13 cases, from one year to seven years, with an average of 3.4 years. In 4 cases the correct dates of onset were not known.

One patient with symptoms of obstruction and bleeding, with stricture observed by x-ray six months after radiation treatment, was completely relieved of symptoms and an x-ray of her colon was normal without treatment at one year. In 2 patients temporary left-sided colostomies were closed successfully.

The largest dose of x-ray therapy was 9,200 roentgen units with the 1,200 kv. machine, and the smallest dose was 1,200 roentgen units with the 200 kv. machine. The largest dose of radium was 6,086 millicurie hours and the smallest was 2,000 millicurie hours.

To avoid injury to the bowel the rays must be prevented from striking it. To accomplish this is difficult in patients that have not been operated upon, but much more difficult in those who may have an adherent loop of bowel.

Perhaps radiation treatment of early cervical cancer is not the best method and perhaps surgery should be more widely used for early cases. This would avoid the dangers of radium and x-ray. The latter combination could be used for more extensive cases where the acceptance of a 3.6 per cent morbidity might be considered insignificant when attempting to cure the disease. About one-half of our cases of bowel injury were in an early operable group, and operation in this group would have been safer than radiation therapy.

It is my feeling that the answer to the apparent increase of bowel injuries is radical surgery for cancer of the cervix in certain cases, the use of high Trendelenburg position plus air injection in others, the use of the full bladder, and possibly the avoidance of x-ray therapy in patients who have been previously operated upon. The Trendelenburg position during treatment has been suggested, but the slanting position necessary is not possible with our present million volt therapy apparatus. Ten of our 34 patients had been operated upon and may have had adherent bowel, in which case this method would not have worked.

Air injection of the abdomen has been suggested, but this would not help those with adherent bowel. Others have suggested injecting air into the rectum and filling the bladder with some solution. Schatzki has suggested persuading the patient to drink plenty of water and treating her when the bladder is full, thus displacing the ileum out of the pelvis and pushing the sigmoid to the left. This would be helpful as the sigmoid and the ileum are most frequently injured. The position of the sigmoid in the pelvis is obviously responsible for its injury, and when a patient lies on her back, the terminal ileum is usually the lowest loop of small intestine and is in the pelvis. If the sigmoid and the small intestine could be pushed aside and out of the pelvis, injuries would not occur, but it is difficult to be sure that they are out of the way during 21 to 30 successive x-ray treatments and 2 radium treatments.

DR. THOMAS C. PEIGHTAL, NEW YORK, N. Y.—Dr. Aldridge has established the incidence of intestinal injury following irradiation of the uterus for cancer in a much more accurate manner than has been done heretofore. His records are most complete, so that his figures must indicate accurately the possibility or probability of intestinal injury in any series treated after the manner of procedure at the Woman's Hospital.

Most papers to date have recorded only major gut complications. In addition to these, Dr. Aldridge has enumerated for us the number of lesser intestinal involvements and has indicated that the majority of these have cleared up spontaneously under symptomatic therapy. Another most instructive feature of this presentation is his study of 11 obstructive injuries and the surgical methods used in overcoming these major complications. That there were only two postoperative

deaths within a few days from peritonitis is noteworthy, as is the fact that in most instances the operative procedure chosen has served its purpose well.

Dr. Aldridge's analysis places the percentage of intestinal complications, mild and severe, at a somewhat higher level than has been previously reported. However, we believe that it is no higher than will be found in most clinics if careful study of present-day therapy is carried out.

I would like briefly to state our experience at the Roosevelt Hospital with a group of cancer of the cervix cases, which includes both service and private patients, particularly those of Dr. Howard C. Taylor. This is a small series viewed against the larger experience of others here, but it is of some interest at the moment in that the radiation technique is so nearly like that used by Dr. Aldridge and therefore the two series may well be compared as to resulting intestinal injuries.

From 1935 to 1941 we have treated 100 cases of cervix carcinoma. These patients have received in and about the cervix and lower uterine canal between 3,000 and 5,000 mg. hr. of radium element in capsules with 0.5 mm. platinum filtration, of which 3,000 to 3,500 mg. hr. have been in the cervical canal. In the majority of instances this radiation was accomplished in one application but in a small number (those receiving a total of 4,500 to 5,000 mg. hr.) 1,500 to 1,800 mg. hr. of the total amount were given as a second application at least six weeks later.

High-voltage therapy either followed or preceded this element radiation at a six to eight weeks' interval with a machine similar to that used by Dr. Aldridge and delivering 45 r. per minute. Daily doses of 220 to 360 r. to one part only have been given (averaging in most cases about 320 r.) A total x-ray dosage of 6,000 to 7,500 r. has been employed, spread over from twenty-eight to forty-two days. (This is 2,000 to 2,500 r. less than Dr. Aldridge states.)

In these 100 cases we have had 13 instances of major intestinal damage as compared to Dr. Aldridge's 12.16 per cent. Nine of these occurred in the large bowel and 4 in the small bowel. In the large bowel 6 showed varying degrees of stricture of the rectosigmoid, some with ulcerative bleeding, but none has required operation. The time of appearance of symptoms of these injuries varied from two months to one year. Three developed rectovaginal fistula, one of which healed spontaneously, the other two being in advanced cases.

In the small bowel, constricting lesions occurred in the 4 cases in five months, six months, six months, and eleven months, respectively, after the termination of therapy. Three required small gut resection and two of these are now alive and free of disease in their fourth year. One, a stump case, who had a loop of ileum adherent to the cervix, developed stricture six months after radiation, and died after resection from intestinal thrombosis.

We have compared this series of 100 cases with 62 others treated from 1931 to 1934, when we were using almost double the amount of radium therapy in two applications but only about one-half the amount of high voltage therapy. In this group there were only 2 rectovaginal fistulas and no small bowel injuries. Thus in our experience with 162 cases we have noted a greater incidence and a greater variety of intestinal injuries since we have stepped up the amount of high voltage therapy given. We believe that gut damage, except in the one stump case, has had little if any relationship to the amount of radium radiation used. In our series it is too early to say whether an increased salvage will compensate for this increased incidence of intestinal damage. As a step toward prevention of these injuries we hope to:

1. Be more conscious of bowel proximity and screen our radium more effectively when necessary;
2. To reduce our daily high voltage dosage and spread it out over a longer period of time.

From our experience we would urge the following:

1. Operative treatment of all small bowel lesions as early as possible after diagnosis can be made. (In our cases x-ray did not demonstrate adequately the multiplicity or extent of these small bowel injuries.)

2. Conservative treatment of large bowel irritations, ulcers, and strictures, as many of the latter which seem at first quite tight may function adequately with patience and time.

3. Dr. Aldridge has pointed out how extremely difficult it is at times to determine whether persistent pain plus mild obstruction may be due to radiation injury or to spread of growth. In such cases if there is satisfactory local regression of the carcinoma and the patient's general condition is improving, we would urge abdominal exploration, as in the few instances in which we have followed this plan we have been repaid by finding a readily remedied benign pain-producing lesion, or very small metastases on the lateral pelvic walls which were not beyond the limit of satisfactory surgical removal. If extensive growth is found, further therapy can be carried out with a sound knowledge of its location and extent.

DR. GEORGE GRAY WARD, NEW YORK, N. Y.—These intestinal injuries are more common than is generally realized. Several years ago we showed that rectal injuries occurred in about 5 to 6 per cent of 688 cases treated and followed up for five years or more. In 1932 Jones, of Cleveland, called attention to the possibility of such injuries occurring months and years later in cases which were not malignant. He reported 7 such cases in 520 patients, 6 of whom he cured by surgery. In 1938 Todd, of England, suggested that these injuries were due to a thrombosis of the smaller branches of the hemorrhoidal vessels causing obliteration of the blood supply of the rectosigmoid, thus producing infarctions and ulceration of the mucosa and fibrosis of the muscular coat resulting in constriction of the bowel. Corscaden has reported similar experiences and recommends the amount of radium be reduced and prolonged so as to give the same ultimate amount of irradiation. He suggests 70 mg. for one hundred hours.

Our former average dosage varied from 3,600 to 4,200 mg. hr. In later years it was increased by using, in addition, the colpostat to the perimetrium for 1,800 mg. more. There is a question whether in stepping up the dosage we may have increased the injuries which we are encountering. Corscaden's suggestion may possibly be an answer to the problem, and I believe there has been a definite improvement in his cases. I would strongly urge a more careful follow-up of these cases as intestinal injuries following irradiation are usually a late complication.

## HORMONAL INFLUENCES UPON THE URETER\*

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THIS article deals with our observations on ureteral peristalsis during the various phases of pregnancy and the puerperium. In addition, we present further confirmatory data that the ureter is subject to hormonal influences which regulate its peristaltic behavior. Before presenting these observations on ureteral peristalsis, a brief summary of our foregoing work on the physiologic changes occurring in the urinary tract during pregnancy is necessary. A portion of this work has previously been presented to this Society.

For many years we have known that dilatation changes occur in the urinary tract during pregnancy, but it was not until the development of intravenous urography, made possible by the original work of Rowntree in 1923 and further elaborated by Swick and Binz in 1929, that we have been aware of its nearly constant occurrence. In our urographic study of 27 normal pregnant women throughout the succeeding months of gestation and the puerperium, the most constant change noted was a dilatation of the pelvis and calyces of one or both kidneys, a dilatation, tortuosity and kinking of one or both ureters, and a lateral displacement of these structures. In addition, there was an apparent atony of the ureteral musculature observed. Every patient showed some deviation from the normal, ranging from a slight dilatation to a marked degree of hydronephrosis and hydroureter. The right kidney and ureter were more affected than the left. The dilatation of the ureter always began at the pelvic brim, and in not one of the patients studied was there found a definite and significant dilatation of the pelvic portion of this structure. With the advance of pregnancy, the dilatation of the upper urinary tract gradually increased to the time of delivery, and following this event there was a rather rapid regression to the normal state, taking place as a rule in twenty-eight days. It is a well-known fact that the presence of frank infection greatly retards the normal involution process. In this urographic study, it was found that with advancing pregnancy and with progressive dilatation of the ureter, the excretion time of the kidney was markedly retarded, so that frequently a delay of thirty to forty-five minutes was necessary before a satisfactory film could be obtained.

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Associated with this delayed excretion time there develops an apparent increasing atony of the ureteral musculature.

We believe that dilatation of the ureter is produced by two primary factors: first, changes in the ureter due to hormonal stimulation, as shown by muscular hypertrophy, increased vascularity, and loss of tone. This changed tube then is subjected to the pressure of the semi-cystic, pregnant uterus at the pelvic brim, with resulting dilatation. We feel that if the primary hormonal changes had not taken place, the soft vascular uterus could not exert sufficient pressure on the dense wall of the ureter to produce dilatation.

From histologic studies we have previously shown that the ureter during pregnancy undergoes rather constant and typical changes. One of the most striking of these is the marked muscular hypertrophy of the sheath of Waldeyer, the outer longitudinal layer of musculature, which structure invests the lower 3 to 6 cm. of the pelvic ureters. There is also seen muscular hypertrophy throughout the length of the ureter, confined for the most part to the circular layer. The ureter becomes vascular, soft, dilated, and ribbonlike. The opinion has been advanced that this hypertrophied sheath is the important causative factor in dilatation of the ureter. If this is correct, the dilatations should be bilateral and should begin at the bladder. Our findings have not supported this view, for as already stated, the changes always begin at the pelvic brim and the right ureter is much more affected than is the left. This increased incidence of right ureteral involvement is due to dextrorotation of the uterus, cushioning of the left ureter at the pelvic brim by the overlying sigmoid, and also to the fact that the right ureter crosses the pelvic brim nearly at a right angle, making it more vulnerable to pressure. The left ureter runs into the pelvis in much more of a straight line and is consequently less subject to pressure effects. We believe the vast majority of investigators are now of the opinion that dilatation of the ureter at the pelvic brim is due to pressure, this being the theory originally presented by Opitz in 1905. We felt that this theory was definitely proved by the experiments we conducted with the use of the indwelling catheter during the later stages of pregnancy. It was shown that if continuous drainage of the upper urinary tract with the indwelling catheter was maintained for forty-eight to seventy-two hours, there was a definite regression of the dilated pelvis and abdominal ureter. Further confirmatory data were added by our studies of the dilatation changes occurring in the presence of large pelvic tumors, especially those of long standing and those conforming to the contour of the pregnant uterus.

Is there sufficient evidence to support our belief that the urinary tract is subject to hormonal stimulation? We feel that the following data support our opinion that this activation does play a definite role.

When one considers the embryologic development of the generative and urinary systems, both arising from the same anlage, it does not



seem too hypothetical to believe that the hormonal influences elaborated during gestation could affect both systems in the same manner. As already mentioned, one of the most outstanding evidences of hormonal activation of the urinary tract is that of the marked hypertrophy of the musculature throughout the ureter and especially in its lower end, namely, the sheath of Waldeyer. This cannot be considered a work hypertrophy, for we found these same hypertrophic changes in a patient dying following an operation for an ectopic pregnancy of seven weeks' duration, when it was impossible to have pressure due to the small size of the uterus. Other evidence to support this hormonal theory is presented by the autopsy findings of a man dying from a teratoma of the testicle with generalized metastasis, which proved to be a chorionepithelioma. Prior to operation the urine had been strongly positive for anterior pituitary-like substance on two occasions. The examination of the ureter showed definite hypertrophic changes throughout the entire organ, but was most marked in the juxtavesical portion. Here there was tremendous hypertrophy of the sheath of Waldeyer, the greatest external diameter measuring 8 mm., the measurement of the normal nonpregnant ureter in the same location being about 3.5 mm. Another factor that seems to support the endocrine theory of ureteral activation is that following delivery, and with the rapid decrease of the hormonal content of the urine due to absence of the placenta, the main source of estrogenic and anterior pituitary-like substances, there is a progressive and rather rapid regression of the urinary tract to its normal state.

Knowing of the work of Traut and McLane on ureteral peristalsis during pregnancy, we wished to confirm if possible their observations, for we felt that the peristaltic variations they noted might be dependent upon hormonal influences and not upon muscular work fatigue as might be supposed. If we could demonstrate that these variations were due to hormonal influences, we would then have additional confirmatory data to support this hormonal theory as an etiologic factor in ureteral changes. Traut and McLane have shown that there is an increasing atony of the ureter with advancing pregnancy, and that beginning with the end of the second trimester there is a complete loss of tone, with absence of peristalsis. There is a return of peristalsis just prior to parturition, which then continues on through and after the puerperium.

In order to carry out these experiments, Trattner's hydrophorograph was used. This apparatus was developed in 1922 in order to make a graphic record of the peristalsis of the ureter in situ through the ureteral catheter at the time of cystoscopy. The hydrophorograph is a closed system; the urine from the catheter passes beneath a tambour, and by this means the variations of urinary pressure are clearly recorded on a constantly moving graph. The pressure under which the

urine flows is regulated by a valve and measured with a manometer, and the frequency of the drops of urine is recorded electrically. A point of practical value is that with the increased intake of water there is a decrease in concentration of sodium chloride ions, thus interfering with the function of the magnetic counter. This difficulty was overcome by placing a tablet of sodium chloride in the tambour chamber, thus increasing the ionization and permitting proper functioning of the drop recorder.

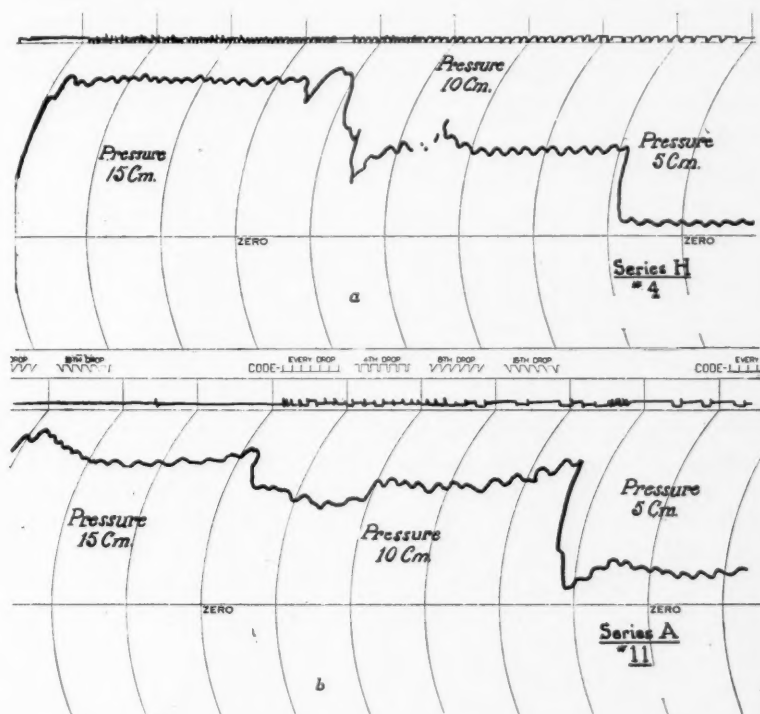


Fig. 1.—*a*, B.S. (b-47). Hydrophorographic tracing, normal patient. *b*, L.Z. (b-25). Third pregnancy, nine weeks' gestation.

The technique of obtaining the tracing was as follows, and was constant throughout the entire study. Each patient received 1,000 c.c. of water one-half an hour previous to the examination, so that active peristaltic behavior would be assured. A water cystoscopy was then done, with the patient in the lithotomy position. The right ureter was catheterized, the catheter marked at 11 cm. and introduced into the ureter up to that point. The cystoscope was then clamped in place so that frequent inspection of the catheter in the ureter during the experiment was possible. The catheter was attached to the apparatus and the instrument placed between the patient's legs; care was taken to see that the kidney pelvis and the tambour were on the same level (see Fig. 2). None of the patients received any sedation, as it was thought that this might interfere with ureteral peristalsis.

In order to ascertain the normal ureteral rhythm, a study of 8 patients with no generative or urinary pathology was carried out. As will be noted, the tracing is made with three variations of pressure, namely, at 15, 10, and 5 cm. of water (see Fig. 1, *a*, B.S.). This hydrophorographic tracing of the normal nonpregnant woman shows regular rhythmicity and amplitude of the contraction waves, the contraction phase about equaling the period of relaxation. The tracing was approximately the same at the various pressure levels. There was rapid excretion of urine.

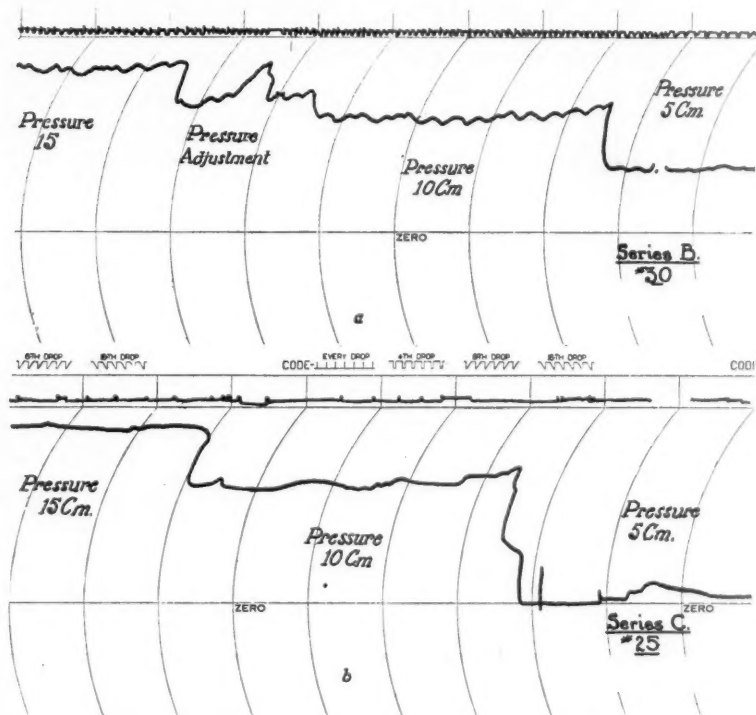


Fig. 2.—*a*, S.C. (b-18). First pregnancy, twenty weeks' gestation. *b*, J.E. (b-20). First pregnancy, thirty weeks' gestation.

After having established the curve for a normal nonpregnant woman, a study of the variations during pregnancy and the puerperium was undertaken; 17 patients were examined during the first trimester, 31 during the second, 46 during the third, 15 of these just prior to delivery, and 12 during the puerperium, making a total of 106. These readings were not conducted consecutively on each patient throughout the several trimesters of pregnancy, for we felt that it might be of greater value to determine the various trimester variations, if any existed. During the early part of the first trimester, the peristaltic wave showed a slight variation in its behavior from that of the nonpregnant control, as evidenced by beginning loss of ureteral irritability, which continued and increased throughout this phase (see Fig. 1, *b*, L.Z., third pregnancy, nine weeks' gestation). With the progress of the second trimester there is an increasing loss of tonus, especially marked with

the pressure of 5 cm. (see Fig. 2, *a*, S.C., first pregnancy, twenty weeks' gestation). Here practically no peristaltic activity is noted. There is rapid excretion of urine. During the third trimester complete loss of tone develops (see Fig. 2, *b*, J.E., first pregnancy). No contraction waves are seen at the various pressure levels. Just prior to parturition

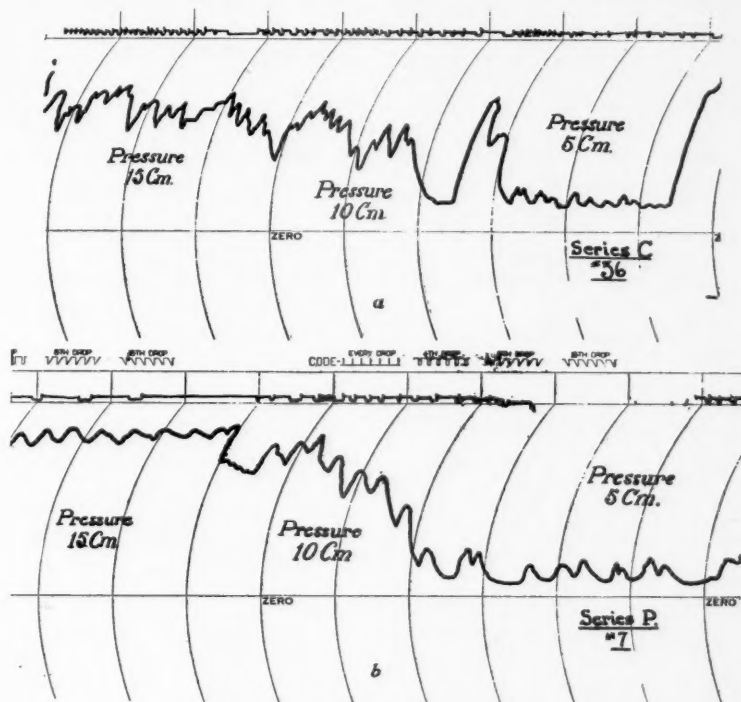


Fig. 3.—*a*, H.C. (b-43). Third pregnancy, thirty-nine weeks' gestation. *b*, L.M. (b-23). First pregnancy, fifth post-partum day.

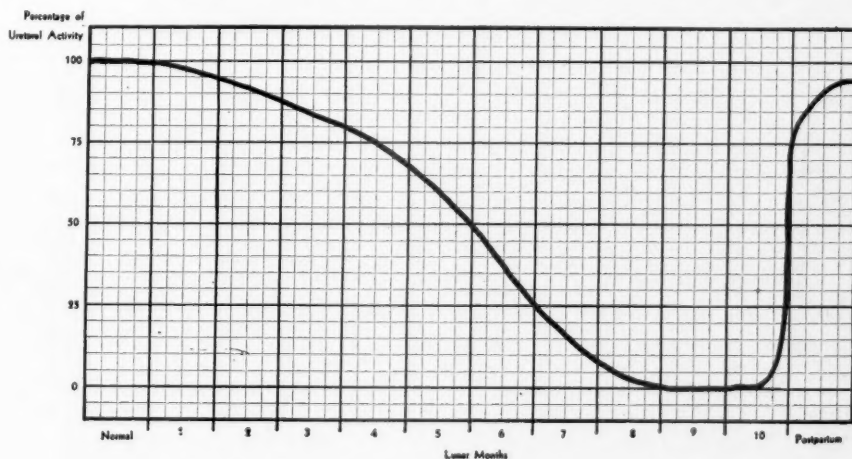


Fig. 4.—Ureteral peristalsis during pregnancy.

there is a resurgence of ureteral activity (see Fig. 3, *a*, H.C., third pregnancy, thirty-ninth week of gestation). Here is noted a definite return of ureteral irritability. During the post-partum period, it is noted that the contraction wave is more regular but there is still evidence of lessened tonus (see Fig. 3, *b*, L.M., first pregnancy, fifth day). Throughout this study considerable variation in the contraction waves at the various pressures was observed. However, it was rather constantly noted that the tracings obtained under 5 cm. of pressure showed quite a low amplitude of peristaltic activity. The explanation of this fact is probably due to there being an insufficient head of pressure, with a resulting decrease of muscular contraction of the ureter. The accompanying composite graph gives a graphic portrayal of the decreasing ureteral tonus during the advance of pregnancy, and also the return of ureteral activity prior to parturition (Fig. 4).

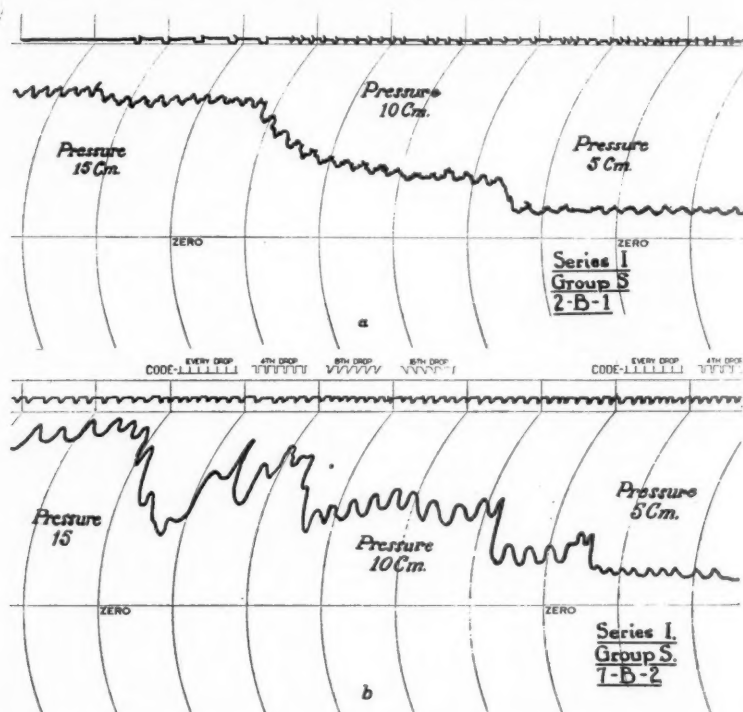


Fig. 5.—*a*, J.H. (b-37). Base line tracing before treatment with stilbestrol. *b*, After one week of treatment with stilbestrol 2 mg. twice daily.

After completing this study of ureteral behavior during pregnancy and observing the very striking atonia that developed, we then attempted to prove that the peristaltic activity and atony were dependent upon hormonal influences. We know that during pregnancy large amounts of estrogenic and progestogenic substances are elaborated in the placenta. The estrogenic substance produces growth and also causes contraction of the uterus, whereas, it is generally thought that the progestogenic substance allays uterine activity. By priming normal women with large and prolonged doses of estrogenic and progesto-



genic substances, we hoped to simulate in a measure hormonal conditions that exist during pregnancy and possibly produce the same ureteral behavior that normally occurs during this period. The experiments were carried out in the following manner:

Eight normal women, the average age being 34, with no urinary or generative pathology, were treated with stilbestrol, each receiving orally 2 mg. twice daily, over a period averaging ten weeks, the patients thus receiving a total of 280 mg. This large dosage produced no

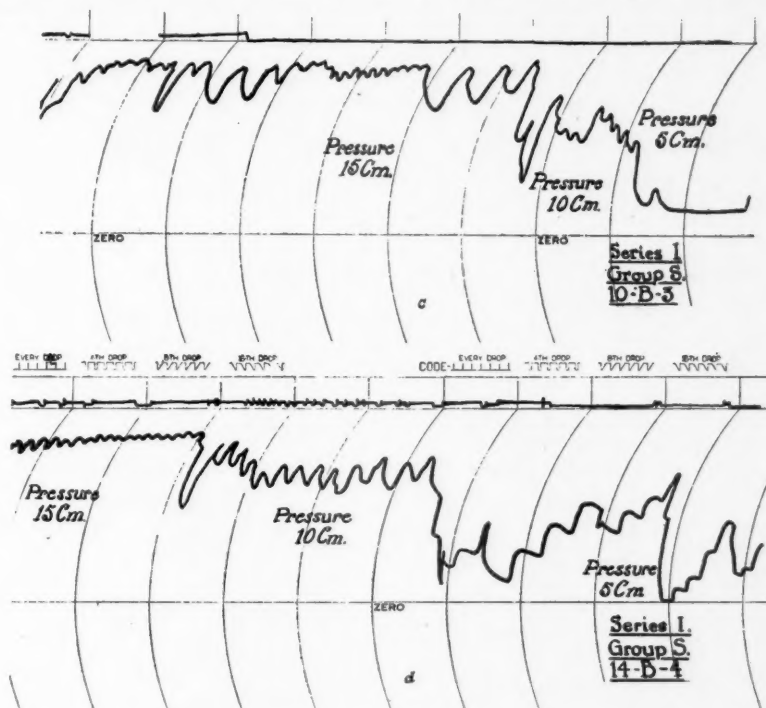


Fig. 6.—c, J.H. (b-37). After two weeks of treatment with stilbestrol 2 mg. twice daily. d, After three weeks of treatment with stilbestrol 2 mg. twice daily.

untoward effects except for slight nausea in several of the patients. Weekly, hydrophorographic tracings were made and, as will be noted, very marked peristaltic activity was produced. The amplitude of the contraction waves was far greater than those seen in the control non-primed patient. As the period of therapy progressed, the ureteral activity became more marked, being quite exaggerated in the last weeks of the experiment (see Figs. 5 to 8).

a. Normal, nonpregnant patient (Fig. 5), base line tracing before treatment with stilbestrol, showing normal ureteral behavior, with active excretion of urine. Throughout the following experiment this patient received stilbestrol, 2 mg. orally twice daily, receiving a total of 140 mg.

b. After one week of estrogenic therapy, there is noted definite increase of ureteral irritability, especially in the 15 and 10 cm. pressure zones. There is good urinary excretion.

c. After two weeks of estrogenic therapy, no very definite activation is seen here. (Fig. 6.)

d. After three weeks of estrogenic therapy, decided increase of ureteral activity is noted. With lowering of the pressure there is seen a decrease in the number of contraction waves.

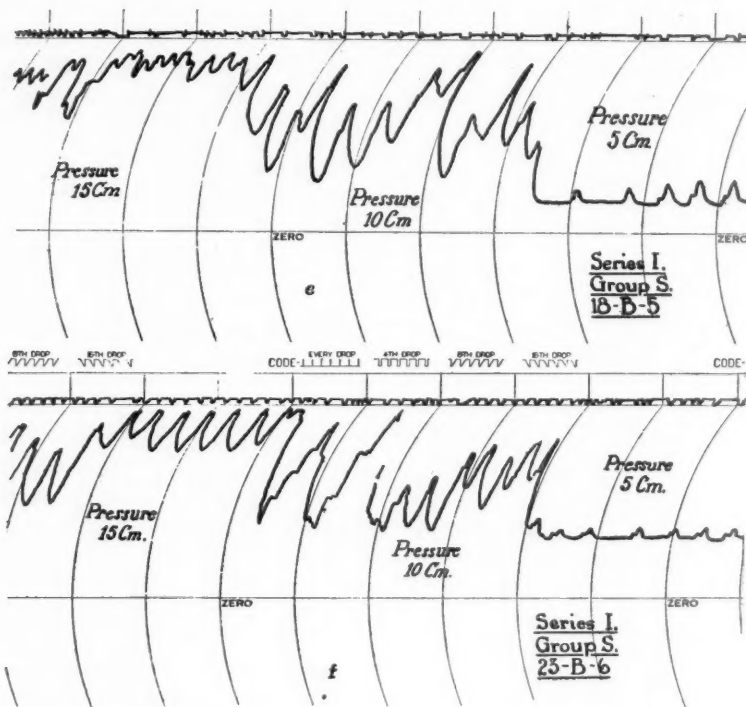


Fig. 7.—e, J.H. (b-37). After four weeks of treatment with stilbestrol 2 mg. twice daily. f, After five weeks of treatment with stilbestrol 2 mg. twice daily.

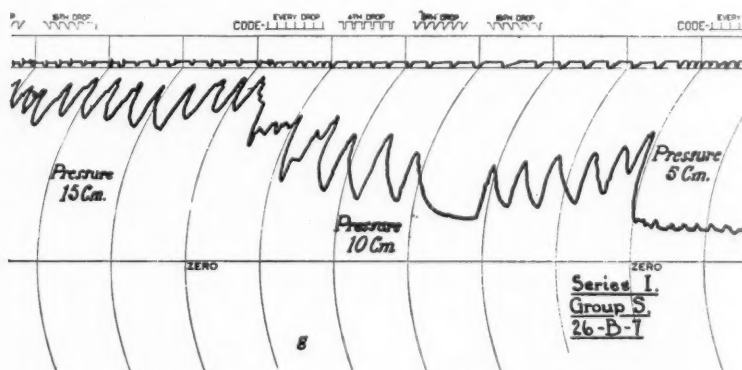


Fig. 8.—g, J.H. (b-37). After six weeks of treatment with stilbestrol 2 mg. twice daily.

e. After four weeks of estrogenic therapy, there is noted a very marked increase in amplitude of the contraction waves, particularly in the 10 and 5 cm. pressure zones. There is good urinary excretion. (Fig. 7.)

f. After five weeks of estrogenic therapy, a continuation of the marked peristaltic activity is seen in the 15 and 10 cm. zones. Very little activity is seen with the 5 cm. pressure. There is good urinary excretion.

g. After six weeks of treatment with the same estrogenic therapy, even more marked peristaltic contractions are seen here and, as in the previous graph, there is little activity in the lower pressure zone. (Fig. 8.)

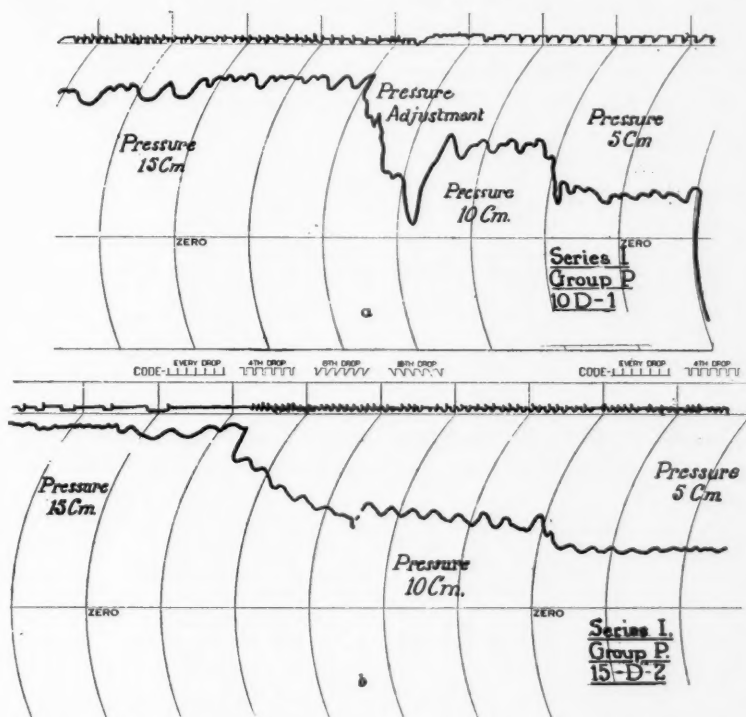


Fig. 9.—a, W.H. (b-29). Base line tracing before treatment with proluton and pranone. b, After one week of treatment with proluton, 8 mg. q.w., and pranone, 40 mg. q.d.

In order to determine if allaying of ureteral activity and final atonia developed under the influence of a progestogenic substance, another group of 8 normal women with no urinary or generative pathology was selected, their average age being 31 years. These women received an intensive course of progestogenic therapy over a period of nine weeks, each receiving weekly proluton 8 mg. intramuscularly, and in addition, pranone 280 mg. orally, making a total dosage that each received proluton 72 mg. and pranone 2,520 mg. No symptoms referable to this intensive therapy were demonstrable. Weekly hydrophorographic tracings were made and, as will be noted in the following graphs, there was a gradual decrease in the amplitude of the peristaltic waves. The diminution of activity increased with the duration of the therapy (see Figs. 9 to 11).

a. Base line tracing of normal nonpregnant woman prior to progestogen therapy. This graph is not as satisfactory as the two previous controls above shown. Throughout the following experiment this patient received proluton 8 mg. a week hypodermically, and pranone 40 mg. a day orally. (Fig. 9.)

b. After one week of progestogen therapy, there is seen a definite lessening of ureteral activity as shown by the decrease in amplitude as well as in the frequency of contractions. In the low pressure zone very little tonus is seen.

c. After two weeks of progestogen therapy, the changes are not markedly different from the previous graph. (Fig. 10.)

d. After three weeks of this same progestogen therapy, there is seen increasing loss of tonus, especially marked in the 5 cm. pressure zone.

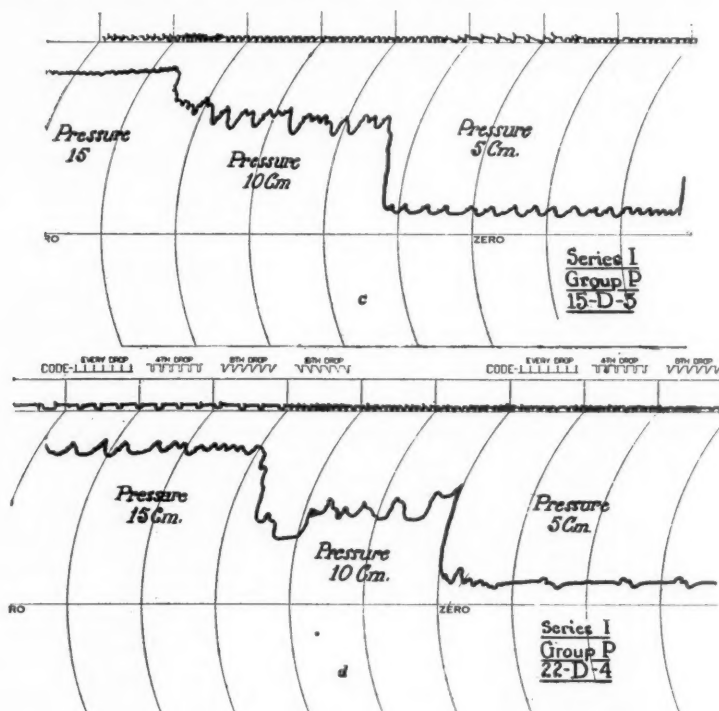


Fig. 10.—*c*, W.H. (b-29). After two weeks of treatment with proluton, 8 mg. q.w., and pranone, 40 mg. q.d. *d*, After three weeks of treatment with proluton, 8 mg. q.w. and pranone, 40 mg. q.d.

e. After four weeks of progestogen therapy, there is nearly complete atonia, most marked in the low pressure zone. The urinary excretion is somewhat lessened. (Fig. 11.)

f. After five weeks of progestogen therapy, complete atonia is observed, especially in the 10 and 5 cm. zones. As will be noted, there is no evidence of urinary output. Urine was excreted, but due to a breakdown in the magnetic timer it was not recorded.

It would seem from these two experiments that hormonal influences play a definite role in ureteral behavior, the estrogenic substance activating the peristaltic contractions and the progestogenic substance allaying these contraction waves.

As we have shown, the peristaltic activity of the ureter during pregnancy may be dependent upon estrogenic and progestin effects. However, from the work of Cohen, Marrian, and Watson it is possible that





From these observations it has been shown that after the third month of pregnancy there is an increasing amount of the combined estrone and estriol excreted in the urine. The estrogens in this state are of low physiologic activity, whereas, it is thought that the free forms may have definite oxytocic properties. As will be noted from our investigations of peristaltic variations during pregnancy, it is in this period, namely from the third month on, that an increasing diminution of activation comes about, until in the third trimester there is complete atonia existing. It is possible that this atonia may be brought about by the inactivity of the increasing physiologically impotent combined estrogen. The absence of contraction waves continues up to just before parturition, when there is a resurgence of peristaltic activity which goes hand in hand with a pronounced decrease in the combined forms and an associated increase in the free estrogen. These free estrogens, having oxytocic properties, may exert their influence on the ureter and cause its reactivation. This work of Cohen, Marrian, and Watson offers an attractive explanation of ureteral behavior. However, as such a divergence of opinion exists in regard to estrin excretion during pregnancy, the possible relationship can only be speculative.

#### DISCUSSION AND SUMMARY

We have shown in previous communications that dilatation changes in the urinary tract are of frequent occurrence, also that typical histologic alterations are noted, for the most part, those of muscular hypertrophy, hyperemia, and increased vascularity. The most striking change observed was the great hypertrophy of the sheath of Waldeyer. We feel that there are two etiologic factors that produce these alterations, i.e., hormonal influences and pressure effects. That hormonal influences do play a role in the ureteral changes is sustained by the following facts: that definite hypertrophic changes do occur in the ureter during pregnancy and also that similar alterations have been observed in the male ureter, the patient dying from a teratoma of the testicle with metastatic chorionepithelioma. With the advance of pregnancy there is an apparent atony of the ureter observed, which belief induced us to study ureteral peristalsis during the various phases of gestation. A summary of this study, determined upon 130 normal pregnant women, showed that during the early part of the first trimester the peristaltic behavior of the ureter was nearly similar to that occurring in the nonpregnant woman. However, as pregnancy progressed there was noted a continued and gradual decrease in the frequency as well as in the amplitude of the contraction waves, until in the seventh and eighth months a complete atonia existed. This atonic state continues up to a short time before delivery. There was then noted a return of the same peristaltic activity as seen during the latter part of the first trimester. In the belief that these variations of ureteral behavior were engendered by hormonal stimulation, we made hydro-

phorographic tracings of normal women who had been subjected to intensive estrogenic and progestogenic therapy. Marked activation of ureteral peristalsis was noted in the group that received stilbestrol, while definite allaying of the contractions was produced by proluton and pranone.

From these observations it would seem that estrogenic substances activate the ureter and progestogenic substances allay this activity.

We wish to express our appreciation to Dr. Louis H. Douglass, Professor of Obstetrics, University of Maryland, for his wholehearted cooperation. We are also indebted to Abbott Laboratories for the supply of stilrone (stilbestrol) and to the Schering Corporation for the proluton and pranone.

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#### DISCUSSION

DR. FRANKLIN L. PAYNE, PHILADELPHIA, PA.—We are led to believe that the common alterations of the ureter in pregnancy are, in part, the result of hormonal stimulation. This theory is supported by the work of Van Wagenen and Jenkins who found urographic evidence of unilateral dilatation in 6 out of 8 pregnant Rhesus monkeys. Cesarean sections were done upon 2 of these animals, with delivery of the fetus, and the retained placentas remained intact for approximately three months. During this time urograms showed ureteral dilatation to indicate that this change is "related primarily to the state of pregnancy and secondarily to the weight of the uterus."

In the current paper, the tracings showing ureteral response to the estrogens and to progesterone are most convincing. Apparently urographic studies were not made during this investigation. With controls prepared from the same patients prior to hormone medication, it would have been interesting to see if their ureters were sufficiently affected by these substances to produce urographic changes.

The results of the essayist's experiments point so clearly to estrogen-progesterone imbalance as the hormonal basis of ureteral behavior during pregnancy that it seems a pity to introduce the Cohen-Marrian theory. This pre-labor reversal of the combined and pure estrogens is still open to question. Even if it is true, its application to the present problem is not valid as an explanation of ureteral atony or subsequent resumption of tone. Throughout the latter part of pregnancy the urinary content of the free (active) estrogens does not fall below, but in fact exceeds that of the nonpregnant state, when ureteral peristalsis remains normal.

In addition, there is abundant clinical evidence of estrogenic activity during pregnancy, as we all know. Furthermore, both the characteristic changes of the pregnant ureter and the delayed post-partum return to normal suggest the response of tissue to a positive stimulus and not the reaction of deprivation.

While this contribution emphasizes the importance of hormone influence in ureteral atony, it does not deny the role of extrinsic pressure in the development of ureteral dilatation. That such pressure does produce changes in the absence of pregnancy was shown by Dr. Hundley previously and confirmed by us in a recent study. Of 96 patients with benign pelvic tumors varying in size from three and one-half to eight months' pregnancy, we found that 66 (69 per cent)

presented urographic evidence of ureteral alterations in the form of either obstruction, displacement, or both.

Dr. Hundley's findings plus this study have suggested another approach to the problem of the pregnant ureter. By using selected patients with myomas, who already present urographic evidence of ureteral disturbance, we propose to test the effects of the estrogenic and luteal secretions upon these structures. Thus we may be able to produce the ureteral changes of pregnancy by artificial means, thereby taking another step in the solution of this interesting problem.

DR. HERBERT F. TRAUT, NEW YORK, N. Y.—In this very interesting study by Dr. Hundley and his associates, it has been demonstrated that the peristaltic activity, and perhaps also the tonicity, of the ureteral musculature can be influenced in the nonpregnant state. Estrogenic substances have been shown to accentuate peristalsis, whereas progesterone has been shown to have a quiescent effect.

Ever since 1848 when Rayer first described the dilated ureters of pregnancy, speculation occurred about the cause of this phenomenon. As a result of many studies, gradual progress has been made toward an answer. As has been shown in this study, ovarian hormones in the nonpregnant woman may have a very marked influence on the ureters. However, we are still in the dark as to the mechanism affecting them in pregnancy. The outstanding characteristic in the ureter of the pregnant woman is the disappearance of muscular irritability followed by dilatation of the tract. Inasmuch as progesterone, at least of corpus luteum origin, and possibly of other origins as well, does not increase in titer in the blood stream after the fourth month of pregnancy, whereas the atony of the ureter reaches its peak at the sixth or seventh month, it would seem very likely that in the pregnant woman there must be other substances which have an effect upon the ureter similar to that which Hundley and his associates have shown progesterone to have.

Furthermore, it is very interesting to know that estrogens, to be specific, estradiol benzoate and stilbestrol, in therapeutic dosage do not produce in the pregnant woman of five to six months' pregnancy increased peristalsis. This statement is made as a result of several attempts to induce better drainage of the urinary tract in pregnant women suffering from pyeloureteritis.

It would seem, therefore, that there are still some steps to be taken before we can know the whole mechanism involved in producing atony of the ureter and stasis of urine in the pregnant woman.

I wish that Dr. Hundley and his associates might have included pregnant women in their studies. One particular obstacle has disappeared from this problem with the advent of the sulfa drugs. At the time we worked on this we had no way of controlling urinary infection in pregnancy except to terminate the pregnancy in the more serious cases. With the sulfa drugs we can cure the upper urinary tract infections and take care of the stasis and atony which we were never able to accomplish before.

## THE SURGICAL TREATMENT AND POSTOPERATIVE CARE OF VESICOVAGINAL FISTULA\*

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DURING the past ten years there have appeared approximately 150 published reports on vesicovaginal fistula. Some of these are single case reports while others include long lists of patients treated. Probably not more than two-thirds of all vesicovaginal fistulas are reported. This does not mean the lesion is common, but it does indicate the subject is far from being a closed book. Indeed, there is reason to believe that vesicovaginal fistula is still very much a contemporary though altered problem. Altered with respect to size of the fistulas, accessibility, and etiology. Time was when most fistulas of this type occurred as a result of long and arduous labor, but all that changed with a better understanding of the mechanism of labor and improved obstetric care. Today the most productive source of vesicovaginal fistula is pelvic surgery. Probably more than two-thirds of these fistulas are the result of pelvic operation, especially hysterectomy. Ample proof on this point may be found in most of the contemporary articles on the subject. Furthermore, it is not unlikely that during this period of international stress caused by World War II, the incidence will actually increase. Certainly with more pelvic surgery performed by less experienced surgeons this is not beyond the realm of possibility. Doubtless the increasing number of hysterectomies and the present enthusiasm for total extirpation significantly contribute to this situation. It is axiomatic that in correcting one disease we must not cause another. Yet, this is happening and it is occurring too frequently. There are too many urinary tract injuries at the time of pelvic surgery. There are too many vesicovaginal fistulas following too many hysterectomies.

Obviously damage to the urinary tract cannot always be avoided, but when 70 per cent of the hundreds of fistulas reported in the past decade occurred subsequent to pelvic surgery and especially hysterectomy, it is questionable whether physicians performing the hysterectomies possess the necessary knowledge and skill which should enable them to minimize trauma to the urinary tract.

Post obstetric fistulas are more often seen in young adults, usually healthy except for the fistula. Generally the opening is large, but accessible when traction is exerted on the cervix. Because most of these

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women are in the child bearing age the blood supply to the involved area tends to be good and the tissues healthy. The postoperative fistula on the other hand, is more commonly seen in older women often past the menopause. The lesion is characteristically small and generally located in a vaginal scar. Since most of the postoperative fistulas follow hysterectomy, they are often inaccessibly located high in the vagina.

In 1935<sup>3</sup> we reviewed the world literature on vesicovaginal fistula. Our present report is based on a study of the literature for the past decade and on experience gained through treatment of 51 cases during the past ten years.

Countless methods and technical variations thereof have been proposed for the correction of these fistulas. Many techniques are best suited for the now uncommon puerperal lesions. Doubtless the extensive loss of tissue and scarring made repair of some larger openings extremely difficult. In our experience, however, the puerperal vesicovaginal fistula, though larger, is accessible and generally more easily repaired than the present-day smaller postoperative lesion.

In the past a good deal of emphasis has been placed on preparation of the patient. This is important but it does not compensate for lack of preparation on part of the surgeon. Since the chances for cure decreases with each operation due to the increased scarring and diminished blood supply, the surgeon should not underestimate the task before him. A small opening may be more difficult to close than a larger one. The operator should have at his command an adequate understanding of the problem. Such understanding when combined with careful preparation of the patient may be expected to result in successful closure in the majority of cases.

Preparation of the patient while aimed primarily at obtaining healthy tissue in the operative field also includes general upbuilding regimen and precise localization of the lesion. Extremely small openings may be localized by air insufflation of the bladder as suggested by M. L. Stadiem<sup>1</sup> or by the instillation of a dye such as methylene blue. Visualization from the bladder side should also be carried out in order to determine the relative position of the fistula in relation to the ureteral orifices and the bladder neck. If the fistula and ureter are in close proximity the latter may be injured at the time of repair. When the fistulous opening is large the vaginal placement of a cervical (obstetric) bag of the Fillis type has been recommended by Angel.<sup>2</sup> This plugs the opening and permits distention of the bladder for cystoscopic study.

From the bladder side most of the fistulas are seen to lie in or near the trigone. Local preparation may also require a preliminary clearing away of redundant mucous membrane tags or incision of scar tissue in order to make surgical correction the easier. This type of surgical preparation is not utilized often enough. The preliminary clearing of the field and incisional mobilization of adjacent tissues to permit approximation without tension later is an important preparatory step



in some of the more difficult, many times operated, badly scarred cases. In all cases an acid urine should be maintained.

Since many of the postoperative fistulas occur in postmenopausal women, 37 per cent in our series, it has been our practice to administer an estrogen for some time before and after operation, generally 0.5 to 1.0 mg. stilbestrol daily. We believe this aids healing by increasing the capillary circulation and epithelization of the vaginal mucous membranes.

Judging from the recorded opinions of many recent writers on this subject and our own experience, there is no one approach or technique of repair suitable for all cases. As in all branches of surgery the technique must be varied to best meet the requirements of the individual patient.

The use of the indwelling catheter immediately postoperative will aid in permitting the closure of many bladder fistulas. From the reports of Deutschmann,<sup>4</sup> Apajalahti,<sup>5</sup> O'Connor,<sup>6</sup> and Thompson,<sup>7</sup> it appears that the usefulness of the catheter as a means of curing postoperative bladder fistula has not yet been fully realized. Prolonged use may not only lead to cure but also aids in restoring the tissues to normal before surgery is instituted.

In all cases here reported the vaginal approach was utilized. Formerly the transvesical and transperitoneal approaches were also used, but since the vaginal route has proved increasingly satisfactory, we have had less and less occasion to resort to these other acceptable methods. While most operators prefer the vaginal route, it must be recognized that good results are also obtained by the other methods. The surgeon interested in the repair of vesicovaginal fistula should be familiar with all procedures, for there is always the odd case that can best be treated by variations of what appears to be a standard method of treatment.

While the vaginal approach was utilized in all of our present series, we are not blind to the merits of either the transvesical or transperitoneal approach. Our preference for the vaginal route is attributed to: (1) Ease of visualization and repair, (2) less trauma and danger to the patient, (3) greater postoperative comfort, and (4) the patient may be ambulatory on the third to fifth postoperative day.

In utilizing the vaginal approach the patient is placed in the inverted Trendelenburg position which permits convenient exposure of the opening. This position with modifications has been profitably used for almost one hundred years and in our opinion is still well suited for most cases.

For the majority of postoperative vesicovaginal fistulas, the so-called split flap technique is preferred. There are many variations of this, but in general it consists of making an incision around the fistulous opening and separating the vaginal from the bladder mucous membranes for approximately one-half inch around the fistula. The bladder mucous

TABLE I.

SERIES NO.	HOSPITAL NO.	AGE	SIZE	CAUSE	NO. PREV. OPERATIONS	RESULT HERE	COMPLICATIONS
1	275586	36	Large	Delivery	1	+	
2	292516	51	Small	Supravaginal hysterectomy	0	+	
3	300544	40	Medium	Hysterectomy	0	+	
4	300259	24	Small	Delivery		+	
5	294066	51	Small	Vaginal hysterectomy	0	+	
6	325938	45	Small	Total hysterectomy	2	+	
7	348845	19	Small	Delivery	0	+	
8	348445	49	Small	Total hysterectomy	0	+	
9	346589	33	Large	Delivery	7	-	
10	346488	34	Medium	Delivery	0	+	
11	338120	26	Small	Delivery	0	+	
12	331017	27	Small	Delivery	1	+	
13	370193	28	Large	Delivery	0	+	
14	353155	24	Small	Delivery	1	+	
15	227961	39	Small	Plastic	1	+	
16	338266	49	Medium	Plastic	1	+	
17	390743	44	Small	Total hysterectomy	2	-	
18	390199	44	Large	Plastic	2	-	Diabetes
19	378232	52	Small	Total hysterectomy	0	+	Healed with cautery. No operation
20	375454	45	Small	Hysterectomy	4	+	
21	402406	44	Small	Delivery	0	+	
22	418086	60	Medium	Vaginal hysterectomy	0	+	
23	420563	36	Large	Delivery	2	+	Bronchopneumonia
24	429384	52	Small	Supravaginal hysterectomy	2	+	
25	422472	51	Large	Vaginal hysterectomy	0	+	Died of pulmonary embolus, 18th day
26	434647	52	Small	Plastic	2	+	
27	344944	49	Medium	Plastic	0	+	
28	443482	43	Small	Delivery	1	+	
29	448118	53	Large	Radium	0	-	
30	448389	67	Medium	Total hysterectomy	0	+	
31	450756	43	Medium	Hysterectomy	3	+	Pulmonary embolus
32	440296	41	Medium	Delivery	2	+	
33	451870	49	Small	Hysterectomy	0	+	
34	451372	27	Medium	Delivery	5	+	
35	276992	68	Small	Total hysterectomy	0	+	
36	438646	24	Medium	Delivery	2	+	
37	436629	49	Large	Bladder stone	3	+	
38	345882	24	Medium	Delivery	1	-	
39	456973	45	Small	Hysterectomy	0	+	Thrombophlebitis
40	470335	42	Large	Hysterectomy	1	+	
41	466403	35	Large	Total hysterectomy	0	+	
42	456819	42	Large	Vaginal hysterectomy	1	-	

TABLE I—CONT'D

SERIES NO.	HOSPITAL NO.	AGE	SIZE	CAUSE	NO. PREV. OPERATIONS	RESULT HERE	COMPLICATIONS
43	263386	36	Medium	Plastic	0	+	Pneumonia
44	474595	55	Small	Total hysterectomy	2	+	
45	484915	50	Small	Vaginal hysterectomy	1	+	Diabetes
46	484718	56	Small	Total hysterectomy	0	-	
47	489156	48	Small	Total hysterectomy	3	+	
48	479087	25	Small	Delivery	0	+	
49	479745	57	Large	Vaginal hysterectomy	0	+	
50	492531	41	Small	Vaginal hysterectomy	3	-	Carcinoma of vagina One kidney
51	478001	42	Small	Plastic	4	+	

membrane is then inverted into the bladder and the vaginal mucous membrane approximated in such a manner as to produce a minimum of tension. The many variations of this basic technique need not be discussed here. However, some of the more important details should be emphasized.

1. The fistula must be well visualized.

2. The tissues around the opening should be sufficiently mobilized to permit closure without tension. This mobilization may be achieved by adequate incision of scar tissue some time prior to operation or it may be accomplished at the time of operation. Since there is seldom extensive loss of tissue in the postoperative fistula, this mobilization is not only essential but generally possible.

3. Whether the suture lines are transverse or one above the other is in our experience a matter of little significance provided approximation be made in such a manner as to minimize tension.

4. Pale ragged, poorly vascularized edges of either bladder or vaginal mucous membrane should be excised.

5. In recent years much attention has been focused on suture material. Doubtless the various types of suture have their good points but so far as vesicovaginal fistulas are concerned our experience and the experience of others would seem to indicate that good results may be obtained with the use of either wire, silk, or fine catgut, provided, and this is important, excessive suturing is avoided and approximation, not strangulation be the function of each suture placed. We have used all three types of suture material but agree with Bertner<sup>8</sup> that fine catgut is as good as any.

6. It is unnecessary and sometimes harmful to produce a water and air tight wound. After all our prime task is to approximate raw surfaces without tension; nature and not our suturing brings about the actual healing. Purse-string sutures should be avoided.

7. Capillary bleeding as evidence of a good blood supply should be a welcome sight. This can be controlled during operation by the use of tiny adrenalin dipped sponges. Excessive bleeding may jeopardize the ultimate outcome and must be controlled.

Postoperative care is important and it is in this connection that our own technique has undergone greatest change in the past ten years.

The use of an indwelling catheter seems desirable but if the fistulous site is near the bladder neck or if the catheter is likely to traumatize the repaired area frequent catheterization with a small straight catheter may be preferable. Similarly suprapubic drainage may be desirable in this connection.

Keeping the patient in the prone position is logical and helpful for reasons already abundantly recorded. When maintained for any length of time, however, this position, whether it be on a Bradford type of frame or on a split mattress, becomes extremely uncomfortable, and even harmful. In addition to the physical discomfort there is disturbed physiology due to the curtailed activity, limited food intake and restricted bowel function. These factors may definitely interfere with the patient's healing ability. Furthermore, there is reason to believe that the prolonged prone position predisposes to embolism. In the past when we kept our patients in this prone position for ten days, massage and movement of the arms and legs were always emphasized. Yet, in spite of this, two of the 51 patients in this series developed pulmonary emboli and one patient died of this complication. Since this happened and partly on the suggestion of Dr. L. Emge and Dr. Albert Pettit of San Francisco, we have kept our patients in the prone position on a split mattress for only two to four days following which the patients are permitted up. Food and drink are allowed as soon as tolerated. The indwelling catheter is removed on the fifth to tenth day and the patient discharged on the twelfth to fourteenth day. This altered postoperative care has made a tremendous difference in the comfort of patients and on the basis of our experience has in no way jeopardized the healing.

The 51 patients treated by us during the past ten years are listed in Table I.

The results in this series show 43, or 85 per cent, cured and 8, or 15 per cent, complete or partial failures.

Experience gained from the treatment of vesicovaginal fistula during the past ten years and a review of the literature during this time warrant the following observations:

1. Familiarity with the technical problems involved and remedial methods available is desirable on the part of any surgeon contemplating the repair of vesicovaginal fistula.

2. Surgical repair should not be undertaken until the involved tissues present a healthy appearance. Excision of mucous membrane tags and the incision of scar tissue to permit free mobilization of the involved area may be desirable before surgical correction is instituted.

3. The inverted Trendelenburg position and the vaginal approach is suitable for most postoperative fistulas.

4. In general the split flap (separation of bladder and vaginal mucous membrane) technique is desirable. Free undercutting to permit union without tension is essential.

5. Probably no one suture material justifies its sole use to the exclusion of others in the repair of vesicovaginal fistula.

6. Preoperative and postoperative use of stilbestrol in women past the menopause is desirable as a healing aid.

7. The use of catheter drainage for some days after operation is advocated.

8. The prone position for three or four days after operation is logical.

9. Patients with small fistulas may be up two to four days after operation without jeopardizing chances for cure.

10. A series of 51 vesicovaginal fistulas treated by me in the past ten years is reported.

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## PARTIAL COLPOCLEISIS AS AN APPROACH TO VESICO-VAGINAL FISTULA FOLLOWING TOTAL HYSTERECTOMY\*

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IT IS significant to note the definite rise in the percentage of post-operative vesicovaginal fistulas as compared with the diminution of those complicating obstetric procedures. This reversal of ratio has become more apparent in the past two decades. It is attributable to the increased amount of pelvic surgery, both abdominal and vaginal, notably the more radical types of operations. The elimination of a cervix that is diseased and may be predisposed to malignant changes has served as the incentive for total abdominal as well as vaginal hysterectomy. The decline in the number of fistulas resulting from childbirth has been due to the advances made in obstetrics: namely, diminution of the hours of labor, better technique of forceps deliveries, and the relative safety of cesarean sections in dystocia.

The causative factors of the nonobstetric fistulas are:

A. Direct injury to the bladder† during operation, which is unrecognized. The importance of detecting bladder injury at the time of operation and a prompt repair by two to three layers of interrupted catgut sutures cannot be overemphasized.

B. Interference with the nerve and blood supply of the bladder, particularly in radical hysterectomy (abdominal or vaginal) for malignancy of the uterus.

C. Clamping or ligating a piece of the bladder in the closure of the vaginal vault, which later sloughs out, producing a fistula.

It must be borne in mind that these fistulas, following total hysterectomy are located high up in the vaginal vault, just above or on a level with the trigone and the ureteral openings. A brief anatomic consideration will enable one to visualize the reason for the location of these fistulas. There is approximately 1 cm. of bladder wall above the trigone which is in close connection to the anterior vaginal wall. The bladder injury usually occurs when the vagina is opened, amputated or sutured. The injury to the bladder therefore is generally near the trigone and in close proximity to the ureteral openings.

After total hysterectomy, the posterior and inferior margin of the bladder is in close contact with the sutured edge of the amputated

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†The instillation of methylene blue solution (1 to 2 per cent) into the bladder by an indwelling catheter has been employed to stain the bladder mucosa. This permits a greater ease in the prevention and recognition of bladder injuries.

vagina, and they are both closely attached to the peritoneum. Since the absence of the uterus and cervix has eliminated the vesicouterine fold of peritoneum; any attempt at the classical method of mobilization of the bladder in this region is not only difficult due to its inaccessibility, but it fraught with considerable danger, for the peritoneum may be easily entered.

There are three methods of approach to such a fistula: transvesical, transperitoneal, or transvaginal.

The question of approach has become a subject of much controversy. Surgeons tend to favor the method of approach with which they are most familiar. Consequently, most urologists are exponents of the suprapubic transvesical operation which was first attempted by Trendelenburg in 1881. It was described in 1890 and was subsequently popularized in Europe. Exponents of this operation claim that there is no danger of opening and soiling the peritoneum. Moreover, the fistulous tract and the ureters are brought into direct view, thus minimizing injury to the latter. If any question arises as to the patency and configuration of the ureters, a catheter may be inserted and the ureters outlined. Various methods have been used to elevate the fistula into the bladder and make it more accessible for dissection: (a) packing the vagina and putting a hook in the packing so as to elevate the fistula (b) the use of a hook or a perineal prostatic retractor. This extraperitoneal transvesical approach has been recommended for high, small, inaccessible fistulas, closely allied to the ureteral orifices away from the bladder neck. It has also been advocated for the repair of fistulas associated with the absence of the uterus and the cervix. I. Farsht has reported seventeen cases cured by the transvesical repair. One-half had been caused by obstetric complications, the other half by previous surgical procedures. Douglass also described four postoperative gynecologic fistulas cured by this approach.

The transperitoneal approach has been extensively employed by Legeue. From 1914 to 1929 he reported 24 cases cured and one death following this procedure. A longitudinal incision is made through the peritoneum on the posterior bladder wall. The bladder is mobilized. The vaginal and bladder sides of the fistula are separated and closed independently with catgut sutures. The suture lines are kept apart and the peritoneum is approximated with fine chromic catgut. Koster, too, has employed the transperitoneal approach and claims good results. He states that peritoneal soiling with urine is minimal.

All authors have emphasized the need of keeping the suture lines apart and, if feasible, of maintaining them in different planes. A new concept for the separation of the two suture lines was introduced in 1937 by W. Waters. During a repair for a recurrent vesicovaginal fistula by means of the transperitoneal approach, he brought down the

terminal portion of the greater omentum and sutured it between the vagina and the bladder. This prevented the sutured openings from coming in contact and also served as a re-enforcing patch. Danforth, in 1940, reported a similar success in a fistula occurring in a nullipara following total abdominal hysterectomy. The operative approach and technique was similar to that of Waters. The omentum in this case, however, could not be brought down to reach the desired area, and the operator therefore excised a portion of the omentum and placed it between the suture lines with fine catgut.

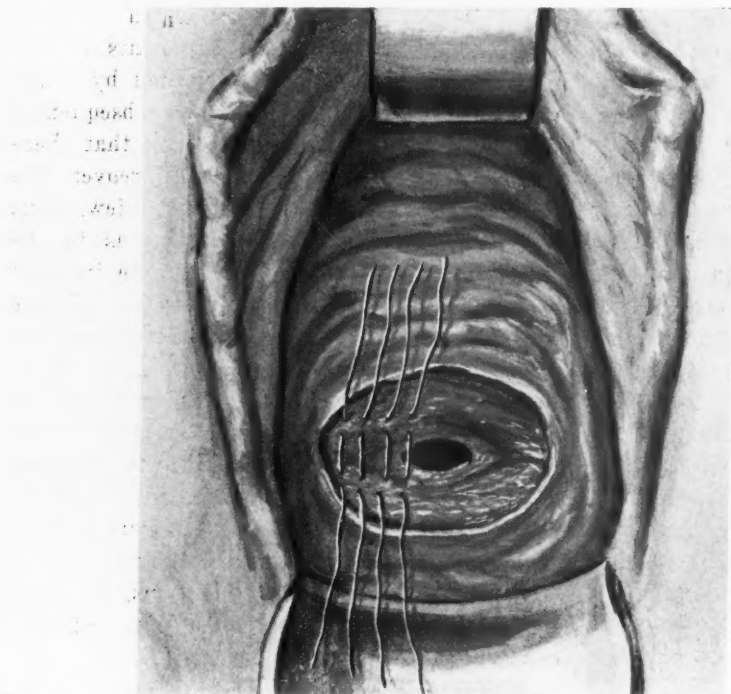


Fig. 1.—A circular area of mucous membrane has been denuded around the fistulous opening and the first four sutures have been placed.

Any of the above-mentioned operations may be attempted to cure a fistula of this type. However, it is a recognized fact that the vaginal approach to cure the fistula has no mortality, a minimal amount of shock, and offers fewer opportunities for complications than do the abdominal or transvesical approach. Being extraperitoneal, there is no danger of contamination of the peritoneum by the leakage of urine.

Partial colpocleisis, the Latzko operation (i.e., partial obliteration of the vagina), is offered as a treatment for vesicovaginal fistula. One rigid criterion exists: This operation should only be performed on fistulas resulting from *total* hysterectomy (abdominal or vaginal).

In this operation one makes use of the posterior vaginal wall as a transplant over the fistulous opening. The vaginal walls being con-

stantly in contact lend themselves readily to this procedure, placing no tension on any of the suture lines.

#### TECHNIQUE

A circular area of mucous membrane 1.5 cm. in diameter is denuded around the fistulous opening; all the vaginal mucosa up to and including the fistulous edge is removed in this area. The fistula is always found on the anterior vaginal wall. The denuded area on the anterior vaginal wall is sutured to the denuded area on the posterior wall in 3 layers, using fine chromic catgut.

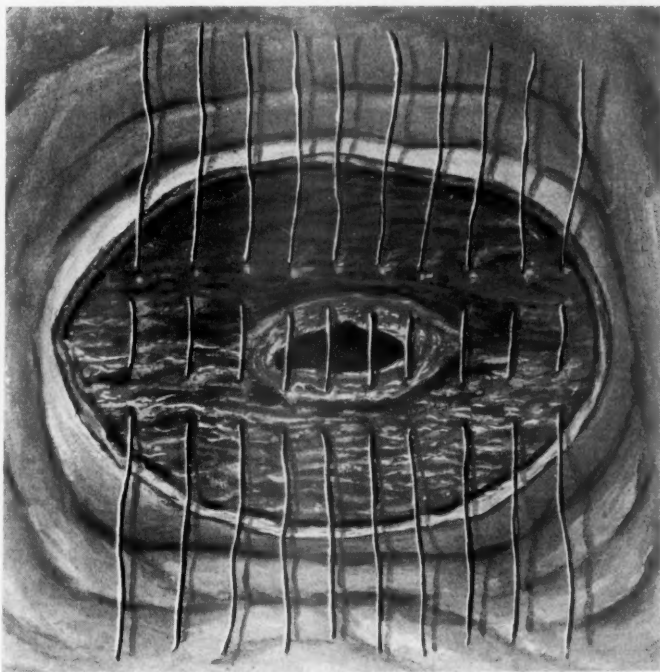


Fig. 2.—The fistulous opening with the denuded circular area around it and the first layer of sutures in place.

If the vagina is nulliparous and tubular, the opening may be enlarged by a simple episiotomy or if more room is necessary, a Schuchardt incision may be used. If the opening is ample but the fistula inaccessible, it can be brought into the wound by using hooks or a Young's perineal retractor.

Most authors stress the need for exacting pre- and postoperative care if successful results are to be obtained. This includes preoperative cystoscopic examination, intravenous urography, and a knowledge of the relationship between the fistula and the ureters. Postoperatively, nearly all surgeons advocate some form of indwelling catheter for two to three weeks in an attempt to keep the bladder free from urine. Some form of urinary antiseptic is likewise employed.

Since mobilization is not needed, the necessity of inserting ureteral catheters and the hazard of injuring the ureters are practically eliminated.

Furthermore, the protracted need for postoperative indwelling catheters has not been found necessary. It should be left in for forty-eight hours and should then be removed and the patient should attempt to void. With the constant flow of urine into the bladder from the ureters, it is impossible to keep the bladder dry even with an indwelling catheter.

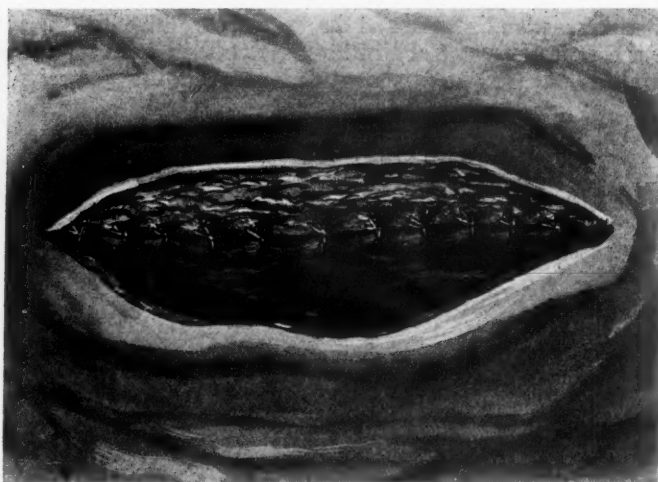


Fig. 3.—First layer of sutures have been tied.

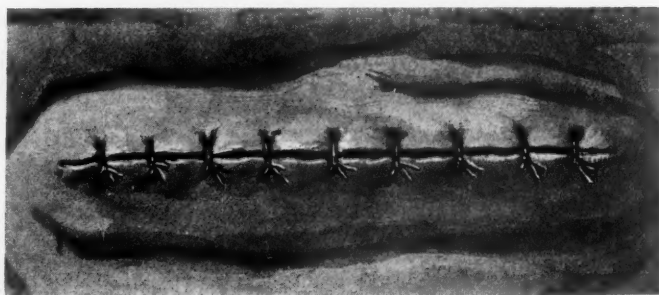


Fig. 4.—The top layer of sutures have been tied. The operation is now completed.

Catheterization should be performed every two to four hours and the time gradually lengthened until the patient can void voluntarily. Overdistention of the bladder need not be feared as it cannot cause any tension on the suture line. Small doses of sulfathiazole, 0.5 Gm. q. 4 h., serves as an excellent urinary antiseptic while catheterization is necessary. These patients are comfortable and move about freely in bed. The postoperative nursing care is similar to any vaginal plastic operation.

#### RESULTS

My associate, Dr. Henry C. Falk and I have performed this operation on four cases, each being successful. I had failed previously to cure one of these cases by the suprapubic transvesical route.



It is not necessary that the interval be long after the injury to do this operation.

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## DISCUSSION ON PAPERS BY DR. N. F. MILLER AND DR. F. C. HOLDEN

DR. LOUIS E. PHANEUF, BOSTON, MASS.—I have operated upon 23 women for vesicovaginal fistulas. Five of these had obstetric fistulas, consequent to vaginal cesarean section in one patient, to forceps extraction in 2 patients, and to version and extraction in 2 patients. Eighteen had surgical fistulas, which followed the interposition operation in one patient, vaginal hysterectomy in one patient, abdominal panhysterectomy in 7 patients, abdominal supravaginal hysterectomy in 3 patients, vaginal trachelectomy subsequent to abdominal supravaginal hysterectomy in 1 patient, the Manchester or Fothergill operation in 1 patient, amputation of the cervix in 1 patient, anterior colporrhaphy in 2 patients, and the Kennedy operation for incontinence of urine in 1 patient.

The smallest number of operations required to close the fistulas was 1, and the largest 7, the majority of these patients having had numerous attempts at closure before being referred to me. In Case 23 the fistula followed an anterior colporrhaphy performed by a general practitioner, who operated six times without success. I was finally successful in closing the fistula at the seventh operation.

The following procedures were employed at the final operation in these 23 women: extraperitoneal closure through a Pfannenstiel incision and implantation of the right ureter in the bladder in one patient; transplantation of the ureters in the sigmoid in 3 patients; vaginal closure in 17 patients; and colpocleisis in 2 patients. Twenty-two women were cured. The twenty-third had shown a satisfactory result at two examinations after operation, but two weeks ago a pinpoint opening was discovered which still may close spontaneously.

The technique which has served me best in the vaginal closure of 17 of these fistulas, some of which were surrounded by dense scar tissue from previous operations, has consisted of free mobilization of the bladder from the anterior vaginal wall, of approximating the edges of the bladder with fine chromic catgut, of avoiding the bladder mucosa, and of uniting the edges of the anterior vaginal wall with silver wire, which for the past seven years has been replaced by rustless alloy steel wire as recommended by Dr. W. Wayne Babcock. I have succeeded by this method, after failure had occurred in the hands of others who had used catgut sutures throughout. The metallic sutures are removed at the end of a month, under intravenous or general anesthesia, in order to permit relaxation of the patient during the intervention.

For the last two decades it has become evident to me that the obstetric fistulas have been decreasing, because of better obstetrics, while the opposite trend obtained with surgical fistulas, due to the increasing number of operative procedures on the female pelvic organs.

DR. RICHARD W. TELINDE, BALTIMORE, MD.—These papers are very timely, for they both indicate that the increased popularity of total hysterectomy has brought with it an increased incidence of postoperative vesicovaginal fistulas. Our own experience coincides with theirs. In the past year I have operated upon 5 vesicovaginal fistulas, only one of which was the result of obstetrics, while 4 were postoperative. Among the latter, three followed total abdominal hysterectomy and 1 followed a cesarean section.

In performing total hysterectomy two things are essential: an observance of the indications for and against the operation, and proper operative technique. We have never had a vesicovaginal fistula in any case in which the Richardson technique of total abdominal hysterectomy was employed.

Dr. Miller mentioned the desirability of cystoscopy and of determining the relation of the ureteral orifices to the fistula. He also spoke of the difficulties in filling the leaking bladder with water. It seems to me the best answer to this is air cystoscopy in the knee-chest posture in which procedure one can always get property dilatation of the bladder regardless of the size of the opening. Even in the high fistulas following total hysterectomy I agree with both the essayists that the best approach is almost always through the vagina. I have never seen a case in which I felt the transvesical approach, as advocated by some urologists, was indicated. Occasionally, the transperitoneal approach is the easiest. After separation of the bladder and vagina and closure of the fistula, one can sometimes bring down a flap of peritoneum over the closed opening in the bladder and thus reinforce the closure.

I agree that fine catgut is, in general, the most satisfactory suture material but in difficult large fistulas silver wire has the advantage that it can be left in for as long as fourteen days without infection. It should only be used for approximating the vaginal mucosa and not through the bladder mucosa. This is true of any nonabsorbable suture material which may cut through the vaginal mucosa and be lost on the bladder side of the closure, where it will invariably form a calculus. We have had two such cases sent to us in the past year, one due to silver wire and one due to silk.

One of the most important steps in the cure of the fistula is the postoperative care. Many a good surgical procedure has been ruined by permitting the bladder to become distended. With this possibility in mind I have recently, in very difficult cases, provided for a double safety valve in the form of an indwelling urethral catheter and suprapubic drainage. I am certain that this double outlet has prevented a few failures for us. The suprapubic tube drains very well with the patient lying on her side. I do not feel that the uncomfortable prone position is necessary. The clear uninfected urine does not retard healing, provided there is no pressure from distention. Another procedure, which I have occasionally used since it was demonstrated to me by Dr. Hunner several years ago, is to make another fistula with a clean cut of the scalpel in front of or behind the closed fistula and leave a catheter in it. Such fistulas almost always close spontaneously and promptly.

Dr. Holden's idea of closure of high postoperative fistulas, by approximation of the anterior and posterior vaginal walls, will, I believe, make many a difficult closure easy. I can see one disadvantage in it, however, in young women for there will be a little shortening of the vagina which may have already been somewhat shortened by the total hysterectomy. We have, on rare occasions, completely closed the vagina as in the following case. Huge recto- and vesicovaginal fistulas appeared twelve years after radium for cervical carcinoma. Closure of either seemed quite out of the question. We first performed a permanent sigmoidostomy and later closed the vagina entirely. The patient now defecates into a colostomy cup, voids through the rectum, and is quite happy.

DR. JAMES R. MILLER, HARTFORD, CONN.—I would like to report a recent case which presents somewhat different principles. A patient, 22 years of age, who had had a panhysterectomy for stroma cell endometriosis, came for the closure of a fistula three months after her original operation. She had a very small introitus and a liberal Schuchardt incision had to be made. There was found a loss of the upper third of the trigone with the right urethral orifice on the edge of the fistula. I circumcised the top of the vagina, mobilizing the vaginal tissue and

utilizing it in the closure of the fistula. Now she has a "blowout patch" of vaginal squamous cell epithelium in the wall of the bladder. It is now twenty-nine days since the operation and the fistula has remained closed. It is my purpose in a few months to treat her with stilbestrol and see if it is possible to evoke a reaction from this dislocated tissue.

DR. N. SPROAT HEANEY, CHICAGO, ILL.—Some years ago I had an interesting experience with a patient who had had an abdominal hysterectomy for carcinoma of the cervix. A recurrence developed in the vaginal vault and one day when her bladder filled up it burst. The recurrence was treated with radium and I was surprised to find that between each application of radium the bladder healed shut. In several cases since that time where there has been a very small vesicovaginal fistula, the size of silkworm gut, I have introduced into the tract a radium needle of 12.5 mg. and have left it in for eighteen to twenty hours. In a number of cases I have had only one case that refused to heal. With this therapy an edema causes the fistula to close for several days with immediate continence. Later it may leak and then close finally after a period of ten to twelve days.

DR. W. LATZKO, NEW YORK, CITY, N. Y.—I would like to refer to 3 cases to show the great difference between the results of Simon's "high occlusion" of the vagina and my procedure, which ought to be called "obliteration of the vaginal vault."

The first patient had a large vesicovaginal fistula closed indirectly by high occlusion, with the formation of a deep diverticulum. The borders of the diverticulum are identical with those of the original fistula. The inferior border is formed by the interureteric ligament and shows the orifice of the right ureter.

In Case 2 the fistula was closed according to my method. No diverticulum is formed but instead of it there is a flat, white scar which terminates in a small niche.

An enormous fistula was found in the third case. The fundus of the bladder and the trigone were destroyed. All that remained was the interureteric ligament which run as a string through the field. The white scar behind the interureteric ligament passed into the hyperemic remainder of the posterior wall of the bladder. The avoidance of the formation of a diverticulum is an obvious advantage of my procedure of obliteration of the vaginal vault.

I have operated upon 31 postoperative vesicovaginal fistulas, most of them having arisen after abdominal radical operations for uterine cancer. All were closed in the indirect manner. The results included one failure by a technical mistake; one improvement to the full satisfaction of the patient, who renounced a further operation. The remaining 29 cases were all perfectly cured by a simple operation.

DR. HOLDEN (closing).—Dr. TeLinde's remark in regard to shortening the vagina is very appropriate. In a shallow vagina we put only two layers of sutures. With a deeper vagina we feel that it is better to use the three layers of sutures.

## MORPHINE SULFATE AS AN OBSTETRIC ANALGESIC\*

### A CLINICAL ANALYSIS

WILLIAM F. MENGERT, M.D., IOWA CITY, IOWA

*(From the Department of Obstetrics and Gynecology, The State University of Iowa)*

IT HAS long been common knowledge that clinically normal babies are sometimes born after the administration of enormous total doses of morphine to patients with toxemia of pregnancy. In one such instance, the child lived and prospered following the administration of 2 gr. of morphine to the mother during the twenty-two hours preceding birth. Similar instances, but with smaller total doses, have been observed with sufficient frequency to prompt an inquiry into the actual and potential dangers of the use of the drug as an obstetric analgesic.

### METHOD

Beginning in March, 1941, a record was made on a punch card (Fig. 1) immediately after each labor of: the type, quantity and timing of the analgesic drug, the type and duration of the anesthetic, various maternal complicating factors, the time at which extrauterine, spontaneous breathing began or the nature of the various resuscitative measures which were instituted and the type of labor. Later the subsequent course of the child was added to the record. The onset of spontaneous breathing, although timed and recorded in fifteen-second periods, was analyzed in two thirty-second intervals. The condition of the child at birth was classified into 4 groups: respiratory distress, as evidenced by apnea after spontaneous breathing or cyanosis, paleness, limpness, and circulatory distress including slow, weak, and irregular pulse. The common resuscitative measures included clearing of air passages with a soft rubber bulb syringe, administration of oxygen, surface friction, immersion in warm water, and the introduction of a catheter into the trachea. Analeptics were seldom, if ever, employed. Breast feeding of all babies was encouraged so that the percentage of breast-fed babies represents to some extent a measure of the normality of the course of the child. Since our obstetric patients are commonly discharged on the ninth post-partum day, the infants do not remain in the hospital a sufficient length of time to warrant using the recapture of the birth weight as an index of their hospital course.

Because this study was directed primarily at achieving a clinical evaluation of morphine sulfate when employed as an obstetric analgesic, the general use of the drug was encouraged, but in practice 60 per cent of the patients receiving it were primigravidas.

\*Presented, by invitation, at the Sixty-Seventh Annual Meeting of the American Gynecological Society, Skytop Lodge, Pa., June 15 to 17, 1942.

## PATIENTS

Among a consecutive series of 1,534 parturient women, analgesic drugs of various kinds and combinations were administered to 807, of whom 386 were primigravidas.

Seven hundred and twenty-seven women received no analgesic drug and served as controls. However, only a very few (58) of these patients were primigravidas, a fact which was considered in evaluation and comparison.

## ANALGESIC DRUGS

There is no routine obstetric analgesic in the Iowa clinic and the chief concern is individualized medication. The kinds and combinations of analgesic drugs employed in the 807 women of this study are shown in Table I and the quantities of morphine, scopolamine, and sodium pentobarbital administered to essentially normal patients in Table II.

[illegible]

Chart 1.—A typical card.

During analysis of the data, certain clinic tendencies became manifest. Morphine was not only given more freely to primigravidas than to multigravidas, but also was employed in the presence of complicated labors in general, and toxemia and prolonged labor in particular. Analgesics other than morphine were employed among multigravidas 4 times more often than in primigravidas. Scopolamine was seldom used alone. Although more than 300 patients received the drug, only 36 had no other.

## ANESTHETIC DRUGS

Since the group of 727 patients receiving no analgesia represents a natural selection of essentially normal multiparas, the type of second stage medication was quite distinct from the other group. Thus, the average normal multipara with no premedication tended to receive chloroform as an analgesic drug intermittently with the pains. It is emphasized that chloroform was never used to produce complete unconsciousness. Obstetric procedures necessitating surgical anesthesia



were always performed with the patient under the influence of some other appropriate medium.

On the other hand various types of inhalation and block anesthetics, selected according to existing exigencies, were administered during the second stage of labor to the 807 women of the group receiving analgesia during the first stage. The types and combinations employed are listed in Table III. In general, patients requiring obstetric operations received cyclopropane.

TABLE I. ANALGESICS EMPLOYED IN ORDER OF FREQUENCY

1. Morphine alone	217
2. Morphine and scopolamine	161
3. Sodium pentobarbital	135
4. Morphine, scopolamine, and sodium pentobarbital	85
5. Morphine and sodium pentobarbital	64
6. Scopolamine alone	36
7. Sodium pentobarbital and scopolamine	35
8. Morphine and miscellaneous (not included above)	28
9. Sodium amytal alone	22
10. Rectal ether	17
11. Miscellaneous (not included above)	7
Total	807
Total receiving morphine alone and in combination	564
Total receiving all other drugs	243

TABLE II. QUANTITY OF THREE MOST COMMONLY EMPLOYED ANALGESIC DRUGS

MORPHINE			SCOPOLAMINE			SODIUM PENTOBARBITAL		
GRAINS	PRIMI- GRAVIDA	MULTI- GRAVIDA	GRAINS	PRIMI- GRAVIDA	MULTI- GRAVIDA	GRAINS	PRIMI- GRAVIDA	MULTI- GRAVIDA
$\frac{1}{8}$	14	14	$\frac{2}{600}$	2	4	$\frac{3}{4}$	0	0
$\frac{1}{6}$	90	80	$\frac{3}{600}$	43	48	$1\frac{1}{2}$	30	14
$\frac{1}{4}$	68	67	$\frac{4}{600}$	75	68	3	60	94
$\frac{1}{3}$	40	5	$\frac{5}{600}$	1	1	$4\frac{1}{2}$	16	60
$\frac{3}{8}$	23	8	$\frac{6}{600}$	8	5	6	13	5
$\frac{1}{2}$	47	4	$\frac{7}{600}$	6	4	$7\frac{1}{2}$	5	5
$\frac{5}{8}$	2	0	$\frac{8}{600}$	8	0	9	2	0
$\frac{3}{4}$	6	1	$\frac{9}{600}$	0	0	$10\frac{1}{2}$	0	1
1	2	0	$\frac{10}{600}$	4	1			
$1\frac{1}{4}$	1	0	$\frac{11}{600}$	3	0			
			$\frac{12}{600}$	0	0			
			$\frac{13}{600}$	1	0			
Totals	293	179		151	131		126	179

Records of all patients with premature babies, pregnancy complications, and fetal death clearly not due to the analgesic medium were excluded.

TABLE III. ANESTHETICS AMONG 807 WOMEN RECEIVING FIRST STAGE ANALGESICS (ORDER OF FREQUENCY)

1. Chloroform, alone and in combination	343
2. Cyclopropane, alone and in combination	289
3. Nitrous oxide, alone or with ether	90
4. Block anesthesia	43
5. Ether alone	8
6. None	34

## RESULTS

A gross comparison among all patients receiving no analgesia, those with morphine alone or in combination, and those with all other analgesic drugs (Table IV) seems to indicate that morphine, alone and in combination, was associated with the highest percentage of respiratory and circulatory difficulties at birth and of fetal death. Moreover, the percentage of low forceps operations in the morphine group was 3 times higher than among the patients receiving other analgesics and 9 times greater than in the control group. Since too many extraneous factors are introduced by study of combinations of other drugs with morphine, or in fact by study of any set of combinations, series of patients receiving single drugs were analyzed. Consideration of the 217 patients who received no analgesic other than morphine, however, did not appreciably alter the figures. Since morphine tended to be employed in the unusual type of patient, it was decided to make certain standard exclusions throughout the remainder of the analyses. These included: all cases where the infant weighed less than 2,500 Gm. at birth, all cases with ante-partum maternal complicating factors, such as placenta previa, abruptio placentae, severe maternal toxemia, and all stillbirths and neonatal deaths at term where the fatality was clearly due to some proved factor other than analgesia, such as macerated fetuses, death associated with diabetes, eclampsia, ruptured uterus, craniotomy, and erythroblastosis. Where no such well-defined and definite entity existed, fetal fatalities were included.

TABLE IV. COMPARISON OF INFANTS RECEIVING NO ANALGESIA, MORPHINE ALONE AND IN COMBINATION, AND ALL OTHER ANALGESICS

(FIGURES REPRESENT PERCENTAGES)

		NO ANALGESIA	MORPHINE	ALL OTHER ANALGESICS
PATIENTS, NUMBER		727	564	243
Spontaneous breathing	1-30 sec.	95.5	79.6	91.4
	31-60 sec.	1.9	10.8	5.8
Fetal distress immediately postnatal	Respiratory	4.3	26.3	15.6
	Pale	1.1	4.1	0.4
	Limp	0.7	9.0	4.1
	Circulatory	0.4	7.9	2.5
Resuscitative measures	Bulb	7.7	18.5	10.7
	Friction	17.2	34.1	14.8
	O <sub>2</sub>	1.4	15.6	5.4
	Tub	1.4	17.6	6.6
	Intratracheal catheter	1.1	6.6	3.5
Breast feeding		73.5	66.0	74.2
Stillbirth and neonatal death		2.3	5.9	2.9
Labor	Spontaneous	94.5	75.2	90.9
	Low forceps	1.9	17.9	5.4
	Other operations	3.9	6.4	3.7

Table V compares 3 series: no analgesia, morphine alone, and sodium pentobarbital alone, after such standard exclusions. The discrepancies among these groups are not so large as in the previous table. Nevertheless, the use of morphine still appears to be attended with considerable respiratory embarrassment, some interference with breast feeding, too many fetal deaths, and too many low forceps operations.

Despite the exclusions previously made, the feeling persisted that comparable series had not been obtained. The group receiving no analgesia was composed almost entirely of multigravidas, while the majority of the patients in the morphine group were primigravidas. A final subdivision of the groups into primigravidas and multigravidas was, therefore, made and tabulated (Table VI). Morphine still seems to be a more dangerous drug than sodium pentobarbital. However, the differences are not so marked, especially in the comparisons among the multigravidas. In fact, in the latter group, the principal point of difference seems to be in the greater percentage of respiratory difficulties, which included mild cyanosis and apnea following spontaneous respiration.

TABLE V. COMPARISON OF GROUPS RECEIVING NO ANALGESIA, MORPHINE ALONE AND SODIUM PENTOBARBITAL ALONE (STANDARD EXCLUSIONS)

(FIGURES REPRESENT PERCENTAGES)

		NO ANALGESIA	MORPHINE ALONE	SODIUM PENTO- BARBITAL ALONE
PATIENTS, NUMBER		666	172	127
Spontaneous breath- ing	1-30 sec.	96.7	84.9	90.4
	31-60 sec.	1.8	9.3	7.1
Fetal distress imme- diately post natal	Respiratory	3.6	24.4	14.2
	Pale	0.8	1.7	2.4
	Limp	0.3	6.9	4.7
	Circulatory	0.0	2.3	3.2
Resuscitative meas- ures	Bulb	8.1	15.1	11.0
	Friction	17.3	23.3	14.9
	O <sub>2</sub>	0.9	12.2	5.5
	Tub	0.8	12.2	5.5
	Intratracheal catheter	0.8	4.1	3.2
Breast feeding		79.9	55.2	77.9
Stillbirth and neonatal death		0.9	1.7	0.8
Labor	Spontaneous	95.3	80.8	89.7
	Low forceps	1.1	16.3	6.3
	Other operations	3.3	2.9	3.9

By the time so many "breakdowns" have been made, the series becomes too small to be of great significance. Nevertheless, it is felt that only by such limitation of extraneous factors is it possible to attain true comparisons. Many papers extolling the virtues of this or that analgesic medium or technique have failed to consider all the factors involved.

A final analysis concerning the fetal effects of morphine in relation to the time interval before delivery was made (Table VI). In general the results agree with those obtained by Shute and Davis,<sup>1</sup> namely, that administration of morphine during the third and second hours preceding delivery is attended by the highest percentage of fetal difficulties. During the first hour, and after the third or fourth hour, the effects of the drug on the fetus are minimal.

Also analyzed, but not presented in tabular form, was the effect of morphine on 22 immature infants weighing between 1,500 and 2,499 Gm. More than one-third of them exhibited respiratory distress at birth, and nearly one-third ultimately died.

TABLE VI. COMPARISON OF GROUPS RECEIVING NO ANALGESIA, MORPHINE ALONE AND SODIUM PENTOBARBITAL ALONE (STANDARD EXCLUSIONS)

		PRIMIGRAVIDAS			MULTIGRAVIDAS		
		NO ANALGESIA	MORPHINE SULFATE ALONE	SODIUM PENTOBARBITAL ALONE	NO ANALGESIA	MORPHINE SULFATE ALONE	SODIUM PENTOBARBITAL ALONE
PATIENTS, NUMBER		54	97	20	612	75	98
Spontaneous breathing	1-30 sec.	90.7	82.5	93.1	97.3	83.0	89.7
	21-60 sec.	3.7	7.2	3.4	1.6	12.0	8.2
Fetal distress immediately post natal	Respiratory	5.6	24.7	10.3	3.4	24.0	15.3
	Pale	1.9	0.0	3.4	0.7	4.0	2.0
	Limp	1.9	10.3	0.0	0.2	2.7	6.1
	Circulatory	0.0	2.3	0.0	0.0	2.7	4.1
Resuscitative measures	Bulb	12.9	15.5	3.4	7.7	14.7	13.3
	Friction	22.2	25.8	6.9	16.8	20.0	17.3
	O <sub>2</sub>	5.6	15.5	3.4	0.5	8.0	6.1
	Tub	5.6	16.5	3.4	0.3	6.7	6.1
	Intratracheal catheter	5.6	6.2	0.0	0.3	1.3	4.1
Breast feeding		59.2	38.1	65.4	81.7	77.3	81.6
Stillbirth and neonatal death		0.0	2.3	3.4	1.0	1.3	0.0
Labor	Spontaneous	88.8	70.1	89.6	96.2	94.7	89.7
	Low forceps	7.4	25.8	6.9	0.5	4.0	6.1
	Other operations	3.7	4.1	3.4	3.3	1.3	4.1

TABLE VII. RELATION OF TIME OF ADMINISTRATION OF MORPHINE TO CONDITION AT BIRTH, NECESSITY FOR RESUSCITATION AND FATE OF BABY (STANDARD EXCLUSIONS). FIGURES REPRESENT PERCENTAGES.) (NO ANALGESIC EXCEPT MORPHINE ADMINISTERED.)

		FIRST HOUR	SECOND HOUR	THIRD HOUR	MORE THAN THREE HOURS
PATIENTS, NUMBER		31	37	36	65
Condition at birth	Breathed 1st 30 sec.	90.4	83.8	72.8	82.1
	2nd 30 sec.	6.5	13.5	8.3	9.2
	Respiratory difficulties	16.1	13.5	30.6	15.4
	Pale and limp	3.2	13.5	8.3	10.8
Necessity for resuscitation	Mild measures	25.8	35.2	41.6	38.5
	Other incl. O <sub>2</sub>	6.5	21.6	38.9	38.5
Fate of child	Breast fed	74.2	70.3	61.2	69.3
	Dead	0.0	0.0	5.6	1.5
	Spontaneous labor	83.8	83.8	80.6	76.9
	Low forceps	12.9	16.2	11.1	20.0

In three cases time interval is not stated.

Most patients received  $\frac{1}{4}$  gr., some  $\frac{1}{6}$  gr., 19 received more than  $\frac{1}{4}$  gr.

## DISCUSSION

It is generally recognized that morphine stands supreme as an analgesic drug. Therefore, its use in labor is indeed rational, if the attendant dangers are not too great. On the other hand the drugs usually employed in reasonable dosages during labor generally produce amnesia rather than analgesia. Because morphine is admittedly a respiratory depressant, most obstetricians use it with caution, if at all. There are, however, others who feel that the fetal dangers resulting from the employment of morphine during the first stage of labor have been exaggerated. Such figures as have been obtained seem to indicate that morphine is not without danger to the fetus, although those dangers are not so excessive as generally believed. One is inclined to agree with Cole, Kimball, and Daniels<sup>2</sup> that "all sedative drugs increase the incidence of asphyxia" and the danger to the fetus "in direct proportion to the amounts used."

Since morphine is not without effect on the fetus, it is of interest to understand how the effect is produced. Snyder and Lim<sup>3</sup> have shown that rhythmical breathing of rabbit fetuses observed within the unopened uterus in a bath of warm Ringer's solution persisted despite administration to the mother of more than 15 times the analgesic dose of morphine. In another publication,<sup>4</sup> these authors report the effect of morphine on labor following delivery of rabbit fetuses from heavily morphinized mothers in two ways, hysterotomy and spontaneous labor. "In striking contrast to delivery by hysterotomy the incidence of stillbirths amounted to 70 per cent when the birth occurred spontaneously." They feel that the "chief damage of morphine is on the labor mechanism rather than directly on the fetus." Such an interpretation would explain the high percentage of respiratory difficulties and fetal death following morphine administration to the mothers of 22 premature infants where admittedly the trauma of labor is relatively severe.

Unquestionably, many factors combine to determine the effect of the drug upon the newborn infant. Two have been mentioned, the timing of the administration in relation to delivery, and the trauma of labor. Other factors include the size of the dose, the anesthetic and accessory drugs. Morphine in therapeutic doses probably does not exert a deleterious effect upon the fetus in utero. In other words, a pregnant woman may be given morphine without stint and without fear for her child. It is only when the drug is administered to parturient women, and then within two to three hours of delivery, that respiratory embarrassment may be anticipated. Even so, Shute and Davis<sup>1</sup> point out, "It is interesting to note that a large number of infants born under optimum conditions for the production of narcosis showed no trace of the effects of the drug." As an example, an infant of the present series breathed and cried immediately, and showed no sign of any difficulty after the hypodermic injection to the mother of  $\frac{1}{2}$  gr. of morphine two



hours and fifty minutes before delivery. In another instance (mentioned in the opening paragraph of this communication), an 18-year-old primigravida suffering from severe pre-eclampsia received 2 gr. of morphine in  $\frac{1}{4}$  gr. doses during the twenty hours preceding her delivery by low forceps under pudendal block anesthesia. She was in active labor for fourteen hours of this time and received  $\frac{3}{4}$  gr. of morphine during the last six hours of labor. The child, weighing 2,930 Gm. at birth, breathed spontaneously, was entirely breast fed and gained weight prior to discharge. On the other hand infants occasionally exhibited respiratory embarrassment and required resuscitative measures following doses as small as  $\frac{1}{6}$  gr. In light of the data presented, this question cannot be adequately answered.

#### CONCLUSIONS

1. The employment of morphine sulfate as an obstetric analgesic is not without some risk of postnatal, fetal, respiratory difficulty, which, however, is readily combated by the usual resuscitative measures.
2. The administration of morphine during the second- and third-hour period preceding delivery probably should be avoided.
3. Morphine seems to offer an excessive risk in premature infants.
4. On the basis of these observations, there is no good reason for the complete discontinuance of morphine as an analgesic in normal labor although its limitations should be recognized.

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#### DISCUSSION

DR. ARTHUR H. BILL, CLEVELAND, OHIO.—I have on various occasions heard members of the profession make the remark that if there were but one drug in the pharmacopeia or if they had access to only one, they would choose morphine. Dr. Mengert has pointed out some limitations and dangers associated with the use of morphine in obstetrics and has emphasized the fact that, although its administration during pregnancy and the early part of labor is without harm to the child, there is a real danger of causing apnea when it is given during the two or three hours preceding the birth. This, in my opinion, is his most important conclusion and conforms perfectly with the practice which I have followed in its use. For the most part I have used morphine in combination with other drugs, notably scopolamine. At the Cleveland Maternity Hospital, this combination has been given in a very large number of cases, more than 25,000, including both private and ward patients, with most satisfactory results and, we believe, absence of danger to the child.

There has been a strict rule that neither morphine nor scopolamine be given within three hours of the birth, and this rule has been faithfully observed in this entire series, practically the only exceptions being the occasional emergency case in which more immediate delivery seems to be imperative. We attribute the safety of this method in a very large degree to the adoption of this rule. This practice, of course, practically eliminates its use in cases of multiparas, but retains for

primiparas a method which is, with little doubt, the most satisfactory combination of analgesia and amnesia.

In compiling statistics on the effect of morphine on the child one should be very careful not to include in the morphine group cases in which the effect of labor itself may have caused fetal distress. Dr. Mengert has carefully excluded most of the cases in which there were other obvious causes of fetal distress. However, more consideration could be given to the numerous accidents of labor. I mention one typical example: a case in which during a protracted labor morphine was given to produce a period of rest. During several hours of sleep labor progressed normally and after six hours the head was on the perineum. At this time there was an unusual amount of bloody discharge and the fetal heart rate increased to 180. The baby was immediately delivered and examination of the placenta showed that there had been a partial separation. The baby lived but was limp and required resuscitation. The fact that morphine had been given during the labor obviously had nothing to do with the fetal distress. Cases similar to this one, and there are many, should be excluded from the list of those in which morphine had been administered when compiling statistics of this kind.

DR. EDWARD A. SCHUMANN, PHILADELPHIA, PA.—Dr. Mengert has used meticulous care in attempting to evaluate the effect of morphine but no one can do this with absolute certainty. For example, in a clinic where there is no fixed routine the primiparas who are more likely to receive morphine are the cases of inertia uteri where it is desired to give the patient a rest for eight or ten hours and it is in just these cases that there occurs the highest proportion of respiratory distress in the fetus.

In some of Dr. Mengert's cases the doses seemed rather high. In our clinic where morphine has been used by preference for some thirty years, the dosage is limited to  $\frac{1}{6}$  grain in twenty-four hours unless suppression of convulsions be required.

I feel that if a patient is given analgesia by some other drug within three or four hours of delivery to a degree comparable with that produced by morphine the effect upon the fetus will be almost identical. It is even common practice in some clinics to give morphine a short time before delivery. With regard to the elective sections done in our clinic  $\frac{1}{6}$  grain of morphine is given as a preliminary sedative before the section is begun.

DR. GEORGE W. KOSMAK, NEW YORK, N. Y.—I never hear a discussion on the subject of analgesics in labor cases that I am not reminded of an incident at Professor Sellheim's clinic in Leipzig some years ago. I was discussing with him the analgesic procedure employed in his clinic. He said, "I have a very simple little mixture here," and showed me a 250 c.c. bottle filled with a light brown liquid. He said, "It is particularly applicable to these younger primiparas. One-half dozen bottles are put into their room and they are told to take one-half the contents of a bottle when their pains become strong, and after a certain period to take another half bottle and repeat it until the labor is completed. It has no bad effects on the mother or the fetus." I asked what it was and he said, "It is just ordinary cognac, and these girls are so inebriated they do not mind labor pains."

DR. MENGERT (closing).—I am glad that Dr. Bill emphasized the rule that morphine should not be given within three hours of labor. Of course, one cannot always calculate the length of labor so accurately, but whenever possible such administration should be avoided.

DR. CURTIS.—Would you mind expressing your views in regard to giving morphine preliminary to cesarean section?

DR. MENGERT.—Generally we have not used it, although on a few occasions we have employed doses of  $\frac{1}{6}$  gr. In the few cases where morphine was used prior to cesarean section, we have seen no harmful effect from it.

## Special Article

### GYNECOLOGIC AND OTHER IMPLICATIONS WHICH RELATE TO AN AGEING FEMALE POPULATION\*

GEORGE W. KOSMAK, A.B., M.D., NEW YORK, N. Y.

**I**T WOULD appear from available statistical information and common observation that, as a nation, we are growing older. If this is a proved fact, and it seems to be so, does it not mean that we are faced with new problems in the care of a group of older people? I may not be able to make an adequate answer within the limits of this presentation because the question to be discussed has wide implications. But there seems to be enough factual information at hand to demand our attention, and it may be opportune to review the situation and to develop the necessary interest among all physicians, including the gynecologist, for its further consideration.

Statisticians are telling us that life expectancy has been extended in comparatively recent decades, that the average span of life among the people of this country has been lengthened from approximately 35 years in 1850 to over 60 years in 1930. In subsequent years it should be even longer. Perhaps by 1960 it may be from 70 to 75 years. In other words, there are more young children and more old people today than there were less than a century ago. These facts have more than a statistical interest, they have definite sociologic, eugenic, and medical implications which, in many ways, are closely related.

Pertinent to our subject, it is necessary to define two words which have come into our medical vocabulary, *gerontology*, which deals with the problems of ageing, and *geriatrics*, which is concerned with the related diseases. Efforts at alleviation of the diseases and other disturbances associated with declining years do not imply a renewed search for the proverbial Fountain of Youth, but a search for the means by which this period of life may be made one of happiness, satisfaction, and comfort rather than of depression, invalidism, and dependency, or of a mere prolongation of what may appear as a useless and unproductive existence.

The particular scope of this paper is centered on women who, while participating with men in similar ailments of advancing years, present certain problems of their own.

Female life expectancy, according to the last U. S. Census, covering the decade from 1930 to 1939, is now 64.5 years as compared with 60.6 for men. In 1900 it was 51 against 48. Life expectancy is, of course, a mathematical average of all persons born alive, and the increase has been developed in great part through the lower death rate in the young. Today the infant mortality rate is 57 per 1,000 for male babies and 53 for females, as compared with 133 and 111, respectively, in 1900. Likewise more young people are living through their twenties

\*Presented, at the Sixty-Seventh Annual Meeting of the American Gynecological Society, Skytop Lodge, Pa., June 15 to 17, 1942.

and thirties, because the inroads of typhoid, tuberculosis, diabetes, rheumatism, and other serious illnesses have been reduced and checked. Women have had less difficulty in childbearing; many of the complications and accidents of pregnancy have been shown to be preventable and have been eliminated to a noteworthy degree by improvements in obstetric practice.

Life tables developed by insurance companies afford further definite evidence of these changed conditions. These show that the proportion of white women born in the U. S. who reach the age of 50 was 61 per cent in 1901 and approximately 84 per cent in 1938. In other words, the average length of life in women has increased from 51 years in

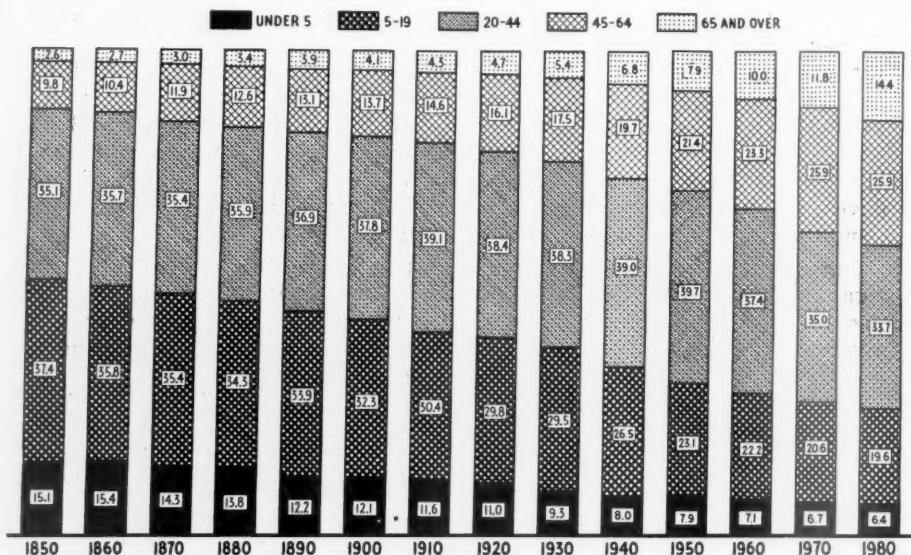


Fig. 1.—This chart shows the age distribution, observed and estimated, of the population of the United States from 1850 to 1980,\* in ten-year periods. If 65 years is accepted as the threshold of old age, it will be noted that in 1850, this group constituted 2.6 per cent of the total population. At the beginning of the century this increased to 4.1 per cent, and in 1940, to 6.8 per cent. If the present trend continues, the 65-year and over age group will comprise over 14 per cent. In actual figures, it has been estimated that the total number of these people will be 22,000,000 in 1980 as compared with 8,956,000 in 1940. (From L. I. Dublin, Metropolitan Life Insurance Company.)

1901, to 66 years in 1938, a matter of 15 years. If we examine furthermore the mortality rates with reference to age and sex we find that, among white persons in a large industrial insurance group (the Metropolitan Life), the excess of male over female mortality is at a minimum in the age group of from 20 to 24 years. Obviously this is due to the special risk of maternity incurred by women during this period. When we go a step farther along in life, the highest excess mortality among males over females is in the age group of from 45 to 54, where it is over 50 per cent. At this time the dangers of childbirth are over among women but, on the other hand, the occupational risks have increased among males. A comparison of these carefully studied figures with those of the general population will disclose little difference.

\*1850 to 1940 from United States census data. 1950 to 1980 estimated by Thompson and Whelpton.



It is further evident from the U. S. Census figures, that all ages have shared in the improvement of mortality rates since the beginning of the century and, if favorable environment, social changes, and medical care can be distributed as universally as possible in what still may be called an imperfect world, the expectation of a longer life may be increased even further. For it has been demonstrated that the various hazards to life, including diseases, accidents, etc., have all been reduced during this period to much lower figures.

Women as a class, however, need to be studied from a somewhat different point of view. It has been assumed that their greatest risk is concerned with their reproductive functions which naturally present a hazard to which men are not subject. A distinction naturally must be drawn here between disease and function. In the male there is little or no disturbance which can be compared with the more serious risk of pregnancy, with its always uncertain dangers of toxemia, hemorrhage, infection, and the trauma incident to labor. Aside from unavoidable accidents, many of these complications of pregnancy can be avoided by adequate obstetric care. Evidently the latter has accomplished good results, because today there is less crippling of prospective mothers, consequently a greater number of them go through the period of hazard and are therefore more likely to have their lives prolonged. As for the menopause, this need not necessarily produce the generally expected disturbances, in view of the increasing knowledge of the effect of hormonal medication and of better general health among adult women.

It may safely be claimed therefore that the lowered mortality from the hazards of childbearing, from the reduction of various disease entities, from improved living and social conditions, has increased the life span of women. On the other hand we must consider as contrasting factors, those associated with degenerative and other illnesses of advancing years and the social, economic, and other pertinent conditions which come into relation with this period. The diseases include mainly those of the circulatory, digestive, nervous, and reproductive organs, as well as the disorders of nutrition and metabolism. An estimate of their incidence is difficult, but here again, a valuable clue may be obtained from the records of insurance companies, particularly those of the industrial type. The mortality rates among female insured persons in the Metropolitan Life, as an example, have moved downward rapidly in the earlier years for tuberculosis, diabetes, heart disease, and other illnesses, due undoubtedly to improved health measures and better medical care. However in the group of women beyond the period in which these more or less acute illnesses preponderate, there will be noted an increase in the number of deaths due to degenerative diseases of the heart, blood vessels, kidneys, and other organs, and of new growths. In other words, as women grow older, they develop many of the ailments once believed characteristic of the opposite sex, once they have survived the hazards of their childbearing years. It is unfortunate, however, that the doctor does not always have this fact in mind and that too often he attributes what are degenerative or alterative processes, in middle-aged women in particular, to mere menopausal or allied disturbances. And so the gynecologist must extend his field of observation beyond the limited sphere of the pelvic organs and become likewise an internist.

In recent years a great interest in the aged has been developed. One is amazed by the extensive literature and by the number and the varied



groups of investigators who have delved into the problem. A perusal of these references unfortunately discloses that, with few exceptions, the clinician, as such, has taken little part. The biologist, the anatomist, the physiologist, the statistician, the pathologist, the anthropologist, and the sociologist have all made noteworthy contributions in a problem to which the clinician, in a broad sense, does not appear to have accorded enough attention.

It would appear appropriate at this point, to attempt a definition of what we mean by old age. Generally speaking, it is a relative term. A human being is born, matures, and then remains stationary or declines. But can we state positively that the latter period should be designated as "old age"? Certain aspects of maturity are closely combined with the latter period, yet this may have little effect on individual activity or personal worth. Some people are more worthwhile and more competent and better able to take care of themselves at sixty than others are at forty. Therefore it would be preferable to measure old age not by years but by competency, both physical and mental, and not to sidetrack people over fifty into the limbo of forgetfulness in so far as their productive and other capacities are concerned.

Admitting an increase in the span of life, how may we account for our increasing number of old people? We must acknowledge among other factors that the saturation point in opening up new frontiers had ceased, practically speaking, at the opening of the century and that the perils of frontier life had diminished, especially for women. Moreover, emigration from less favorable regions abroad has diminished in the last forty years, with a lessser incidence of previously acquired illnesses due to inadequate diet, severe muscular labor, exposure, etc. We see this reflected particularly in the reduced incidence of rickets and bone tuberculosis, among other crippling conditions, with their possible effect on childbirth. The advances in preventive medicine likewise have become more widely applied in most American communities and therefore inroads of devastating illness have been checked.

While women have participated with men in the generally improved conditions of modern civilization, they present as a class another interesting picture. Among other things, it must be acknowledged that within our generation a great psychologic change has taken place. Women not only have become emancipated in a political and social sense, but they have endeavored to sidetrack old age in so far as personal appearance and activity are concerned. No longer is the woman of fifty, even if she be a grandmother, satisfied to put on what were formerly regarded as the habiliments of that period. She endeavors to preserve her figure, she clothes herself in raiment of a pattern like that of her daughter, she participates in the activities of youth to an extent which often is a discomfort and embarrassment to the opposite sex. She refuses, in other words, to become old. Sooner or later, naturally, she must succumb, but she does it with more resistance and all this may, and probably has helped, to prolong her life, aside from what we doctors have claimed to have done in our efforts to improve her health. That woman is as old as she looks, was never a truer proverb than it is today.

However, the recital of all these pleasant things cannot deter us from giving careful thought to the inevitable consequence of failing vital functions and other matters, which even the beauty specialist cannot hide or overcome.

The life span of women may be considered in three periods. The first ends with maturity, as interpreted by the ability to conceive, the second includes the years of reproductive capacity, the third comprises a period of rest and retrogression. In all of these the collected organs of generation play an outstanding part, but they are closely integrated in their functions and development with the other systems in the body which serve to maintain life and in its various phases.

The question as to the reasons why more women reach an advanced age has already been referred to. How does this affect the larger aspects of the medical and social problems in which physicians have an interest? For a possible solution we must approach the subject from various angles. Leaving aside other factors, it may be said that a better knowledge of the growing organism and maintaining it in good health, have brought more young women through the critical period of child-bearing with less damage. This applies in particular to the better knowledge of endocrinologic disturbances and their treatment in young and middle-aged women, as well as to the advances in obstetric care. While much remains to be done in the latter field, the reduced puerperal mortality rate and the greater salvage of infant life are evidences of accomplishment. It means that fewer women are crippled by child-bearing and that they reach their later years in a better condition of health. In addition, we may expect a lesser incidence of those degenerative diseases, particularly of the heart and kidneys, which may be traced to a lowering of the occurrence of the formerly more common infectious diseases.

Granting the above factors, among others, as productive of an increased older age group among women, the admission must be made that in consequence we are faced with a larger incidence of those diseases of a purely degenerative type peculiar to advanced age. And in this connection, one cannot discuss the medical implications of an increasing number of ageing people without considering the social problems involved. If inability to care for themselves develops, is it incumbent upon society to undertake the task? If there are more dependents in the years to follow, is the burden for their care to be saddled on the younger generation? Can we accomplish the desired end by increasing the number of almshouses and similar institutions, by various old-age security measures or by politically engendered pension schemes? As physicians we may have less interest in these phases of the subject, but we have a responsibility as regards the medical implications of the problem. Preventive measures must be developed to avoid what have been regarded as the unavoidable accompaniments of old age and curative measures employed when we develop, after due study, the necessary technical knowledge. An ounce of prevention is nowhere more effective than a pound of cure than in this particular field of medical practice.

It is not feasible within the limits of this presentation to discuss fully the symptoms and treatment of the various illnesses that pertain to the ageing group of women. We can refer only briefly to some which appear more noteworthy in a general sense and follow this with the gynecologic implications of the problem. This includes the nutritional and metabolic disorders, the organic diseases, and the mental and psychologic aspects, as among the more noteworthy.

## NUTRITION AND METABOLISM

For centuries the importance of proper and adequate nutrition in preserving life has been acknowledged yet, until recently, more attention has been accorded to infancy and youth than to mature life. The fact must not be lost sight of that rapid chemical change is prevalent in youth, for the need of adequate growth is more essential during that period. After this is attained, the requirements are lessened, although the desires and opportunities for change in foods perhaps are more easily gratified and overindulgence or false indulgence may prevail. Moreover, because of the diminishing rate of chemical change, it requires more time to produce a desired effect. The relative admixtures of proteins, fats, and carbohydrates needed in older people have not been fully determined nor can we hope for careful caloric measurements as a guide in ordinary life. An average of 2,500 calories for a hard-working woman is apparently excessive for one leading a sedentary existence. Women, as a rule, indulge freely in carbohydrates, a tendency which it seems can be curbed only with difficulty.

Unfortunately there is insufficient clinical evidence to demonstrate the effect of specific diets in man—observations in lower animals have been relied upon largely for information. However, in recent years laboratory research has been conducted by a number of investigators who claim that diets rich in vitamins and poor in purified foodstuffs have an influence in preventing degenerative diseases. But the question of essential protein intake is still in dispute, and whether this, e.g., shall be from milk or meat, is open to question, as well as the effect on kidneys and blood vessels, measured by the consequent occurrence of chronic nephritis or hypertension.

Basal metabolism shows a definite decline with the onset of years. As the body fails, the rate frequently diminishes with other functions, but variations in values indicate that senescence is more than a matter of time. While the ability to digest would seem impaired with increasing age, the ability to utilize food does not appear to be greatly affected, for there is little evidence, among other things, of any progressive senile atrophy of the gastric and intestinal mucosa.

Changes in the mineral content of the body, in the tissue fluids, in fats and other substances, have all been studied and shown to vary from youth to old age, but about the underlying biochemical processes we have scant information. A cooperative attack is needed to confirm the hope that life can be prolonged by manipulating the diet. At any rate, if limitations can be formulated, this may avoid the distress associated with digestion in so many old people.

## ORGANIC DISEASES

Changes in the essential organs necessary for the maintenance of life, are usually associated with declining years. These include the nervous, circulatory, digestive, genitourinary, osseous, muscular, and glandular systems. The male sex may present a preponderance in one group, the female in another, but with few exceptions, we find an incidence more or less equal in both. Let us review some of these briefly.

*Nervous System.*—Aside from the acute mental disturbances of which the origin may be in question, a relationship between nervous involution and arteriosclerosis has generally been assumed and mental senility, cerebral accidents and other phenomena attributed to the same. All

this is covered by the formerly popular designation of "hardening of the arteries." Yet with the more routine and widespread employment of actual blood pressure measurements, we often find abnormally high readings in younger people and equally low readings in the aged. Older men do not appear to have a monopoly of high blood pressures; women also are afflicted and are more puzzling subjects for treatment, because generally there cannot be the ready resort to such precautionary advice as restrictions in alcohol, tobacco, and perhaps certain foods, the abuse of which usually is associated with the male sex. Some neurologists have asserted that ageing of the nervous system is independent of degenerative changes of the cerebrospinal blood vessels and, although these may be associated, there is no direct causal relationship between arteriosclerosis and cerebral involution. On the other hand, the more acute apoplexies and thromboses can be attributed only to arterial sclerosis, so that attention must continue to be extended to preventive measures in earlier life if we want to avoid their destructive effects later on.

*Circulatory System.*—In considering the circulatory system in ageing persons, we must take into account both the structural and functional changes. The demands on the heart vary greatly from youth to old age. In earlier life it is more liable to reflect the effects of infectious disease and, in women, such damage is often aggravated by the processes of childbearing. But, as a rule, the strain on the heart is less in women than in men. Yet the organ undergoes alterations in the course of time, and it would be desirable to have established a normal curve for cardiac activity and function which can be employed for successive decades of life. Surely a desirably functioning heart in a woman of 70 would present different standards from that of a woman of 30. We should have practical methods for ready estimations and perhaps the electrocardiograph experts in time will furnish them. In this connection we must also take note of the altered composition of the blood, considering this as an organ, and of the antibodies and other essential constituents which vary with age.

*Digestive System.*—It is generally accepted that digestion wanes with age. How much of prevailing indigestion may be due to previous indiscretions and how much to an actual wearing-out process, is not yet clarified. It has been shown that the quantity of saliva diminishes and likewise the ability to secrete hydrochloric acid freely after eating. However, there is little evidence to show that the gastric mucosa itself undergoes much change. Achlorhydria may be compatible with good health but predisposes to anemia, inadequate calcification of bone, and enteritis. Although the death rate from ulcers of the stomach or duodenum increases with age, their onset rarely occurs after 60. The relation between gastric ulcer and cancer is still debatable but it is stated that after 45, gastric cancer causes death 6 to 7 times more frequently than ulcer. As for liver changes, the cirrhotic processes associated with advanced years are believed to be due to pathologic conditions rather than to senescence. The stasis of the gall bladder associated with pregnancy is claimed to be responsible for the higher mortality in women from diseases of this organ in later life. Hernias, adhesions, and neoplasms, with consequent obstruction, increase with age but are amenable to treatment in a surprising number of cases. While constipation is usually assumed to be an accompaniment of old age, it has been shown that it is usually a lifelong complaint and, if of recent onset, indicates most frequently an obstructive neo-



plasm. The psychologic effect of satisfactory bowel evacuations varies with the individual. Elderly women grow careless, with resulting obstipation, and this calls for adequate treatment. Perhaps the dictum of the great American humorist, Josh Billings, still holds, namely, that "a good reliable set of bowels is worth more than any quantity of brains."

*Urinary System.*—It is generally assumed that the kidneys fail in old age. Death from this cause results perhaps more frequently in men than in women. However, if primary senescent involution does occur, its effects, according to several authorities, are overshadowed by the secondary tissue changes which follow normal ageing of the renal arteries. The lack of a proper blood supply and the resultant hypertension seem to be the factors which cause the disturbances. The practical value of these conclusions may in time be reflected largely in timely preventive measures yet not fully understood or capable of practical application.

*Reproductive System.*—Advancing age in woman is associated with the decline in her reproductive powers, and the menopause has been regarded as the dividing line. Yet we must admit that in a general sense this is not true. The reproductive period may have ceased, genital atrophy may begin, the sexual function may wane, but how many women today feel that they should be labeled as "old" at this time? The menopause occurs while other bodily functions frequently are still in their prime. Its accompanying disturbances may be effectively treated in ordinary cases, as well as in those where it has been induced artificially. However, hormone therapy has met with such good results that it is administered very frequently in a haphazard fashion. The pituitary and the thyroid have an importance perhaps equalling that of the ovary, yet these glands are generally disregarded in the prescriptions for treatment. The estrogenic substances, as such, should be given as a measure of alleviation for the disturbances associated with diminishing ovarian function, not to prolong the latter.

The possible occurrence of cancer of the generative organs constitutes the greatest source of concern to women. There is a tendency toward various neoplastic diseases at, or after, the menopause, in which the breasts, the ovaries, the uterus, and accessory structures may participate, but these are not necessarily all malignant. Just what effect hormonal changes may exert on the production of malignant tumors in women, has not been determined definitely. More recently it has been claimed that it is due to an endocrine imbalance involving the pituitary and adrenals. Vitamin disturbances are also accused. Cancer is an uncontrolled growth and just what removes the restraint in certain organs, when others continue to function normally in the ageing body, is unknown. Perhaps at some future time we can regulate the process but at present, early recognition and appropriate surgical or radiation treatment probably offer the best solution.

The incidence and mortality from cancer of the female generative organs constitute a field of wide interest and cannot be summarized briefly. Collected statistics have been developed by various agencies of which those made in New York probably reflect the situation throughout this country. In New York City, T. J. Duffield, Registrar of Vital Statistics of the Department of Health, states that cancer ranks second among the leading causes of death and the recorded cases in New York City have increased about 73 per cent since 1901. Unquestionably some



of the increase in the latter has been due to improvements in diagnostic methods and to a wider opportunity for their use, but we can also attribute it to the increases in the middle and older age groups, where cancer is likely to be more frequent. In 1901 only 3.5 per cent of the deaths in New York City were charged to cancer; in 1940 this had increased to 16.2 per cent. This includes both sexes but it is of interest that death rates among males slightly exceed those among females, contrary to the popular belief.

L. C. Kress, Director of the Division of Cancer Control of the State Department of Health, favored me with a recent report of the situation in New York, excluding the greater City, during 1941. The case rate of reported cancer of the female genital organs in New York State per 100,000 population, was 7.13 during the age group from 55 to 64; 17.44, in that from 65 to 74; and 25.37, at over 75 years. The corresponding death rates in the same age groups were 4.99, 11.99, and 14.99 and the case-death rate ratios were 1.43, 1.45, and 1.69.

In the detailed table submitted with this summary, the ratios between case rates and death rates show a definite decrease in each succeeding ten-year period from 35 to 75 years. Although the degenerative diseases undoubtedly play a great part in causing deaths in older people, the death certificates give preference to cancer, where this is mentioned either as primary or secondary cause, over other diseases except those of a communicable or accidental nature. What direct effect increasing age, with its weakening factors, may have on this ratio cannot be estimated from the statistics on hand, so that my belief that cancer possibly is less malignant in older women must, for the present at least, remain a matter of doubt.

Unfortunately the incidence of malignancy in the population as a whole is not known definitely, so that we are unable to estimate without further study what actual improvement in the handling of cancer cases has resulted from more modern methods of treatment. Perhaps this would constitute an interesting topic for study by a committee from this Society.

#### OTHER ORGANS AND SYSTEMS

Time does not permit a discussion of the changes which take place in the bones, muscles, joints, teeth, skin, and the organs of special sense. These are mostly accepted as evidences of advancing age. But much can be done in the way both of palliative and curative measures to reduce the attending disturbances and crippling effects. Nor have I included any detailed references to the respiratory diseases, which figure so largely in the mortality rates of the aged and in which lowered resistance is often the determining factor.

Pneumonia may well be considered with influenza and affects every period of life, although most prevalent at the two extremes and more among men than women. Pneumonia of all types is a very dangerous disease at any age, but advances made in diagnosis and treatment will undoubtedly lessen its fatality rate even among the aged, in whom it so often constitutes a terminal condition. The control of pneumonia remains a public health problem of the first magnitude.

In addition to the foregoing, psychologic manifestations associated with the advent of old age are accepted quite casually as a usual accompaniment. It depends, however, upon who makes the estimate, for youth and older people are by no means in agreement as to relative

values. Youth associates its own period with activity and progress and regards advancing age as characterized by lack of desire, satisfaction with past accomplishment and general resignation. Wisdom as a result of accumulated experience is not always accorded to age by youth. This is well shown by the impatience shown by young women toward the ideas of marriage and childbearing entertained by their mothers and grandmothers. However, it should be acknowledged, although perhaps grudgingly by youth, that mental capacity, among other things, is not necessarily measured by years of existence and that actual mental derangement is not necessarily an accompaniment of old age. Naturally, we must admit that, among organic systems, including the nervous, deterioration in an anatomic and physiologic sense must result in dysfunction for the process is irreversible, but we are by no means certain of the effect of environmental and other factors and of personality changes. It may be possible that further exploration by the psychotherapist will lead to the correction of influences that are depressive in character and that the personality changes so characteristic in older people may become less prominent as reasons for relegating them into the discard. Moreover, I cannot agree with the claim of so many psychologists that sexual impotency alone is the basis for mental retrogression in the aged or that it would not be possible to develop a feeling of contentment by a properly preserved state of good general health outside of the sexual sphere. Women perhaps manifest less evident disturbances in the latter than men, because they are untroubled by such distressing factors as an enlarged prostate and its complications.

Leaving out of consideration such definite disturbances as actual senile dementia and bearing in mind that ordinary changes in personality are not to be magnified into evidences of unconquerable senility, it becomes essential in this complex society of ours to develop new social adjustments between young and old, so that the best functions of all ages can be fitted into a scheme in which individual differences, rather than age differences, are more fully stressed, as so well stated by Walter R. Miles in Crowder's book on the *Problems of Ageing*.

Perhaps I will be regarded as wandering from my thesis in stating that, in my belief, there are certain eugenic factors that enter into the consideration of the problem of the ageing woman. The eugenists have called attention to the importance of selective breeding, not only among domestic animals but among human beings. Healthy children demand healthy parents for their creation, and children who have a good physical start in life are more likely to reach and go through advanced years with less difficulty and, in consequence, with greater independence. In other words, competent and responsible married couples should have more children than their irresponsible neighbors. Unfortunately that is not the sort of society which prevails today and pregnancy seems governed largely by the elements of chance and expediency. A solution would be offered if it were made possible for young people to begin parenthood earlier without jeopardizing their standard of living, and if as much attention were given to methods for favoring conception as for those devoted to its prevention. Only too frequently the favorable time for pregnancy is postponed for social and other reasons. The best period for childbearing is believed to be in the twenties and early thirties. Although women now live longer, their procreative period remains the same, and we cannot hope for babies when ovulation ceases.

We cannot balance infertility in youth by looking forward to its recrudescence at an age when economic conditions may be more favorable. Therefore, we may hope for a healthier group of older women if their childbearing are limited to the proper age and number of offspring, even if we cannot proceed further from the standpoint of eugenic selection. No doubt, such philosophy will be disputed, but some day it will prevail when reason rather than chance can dictate in the matter.

#### OPERATIONS ON OLDER WOMEN

The question of operations in an increasing number of older women has necessitated a resort to changes in procedures which were designed primarily for a younger and more virile group. This applies particularly to pre- and postoperative handling as well as to the important detail of anesthesia. Sufficient evidence is at hand, however, to warrant and permit necessary operative intervention, when indicated, in elderly women who, in former years, would have been turned down as too great a risk.

Several of my colleagues in response to questionnaires have favored me very kindly with their statistics and opinions on this subject.

Dr. Richard TeLinde, reporting on the gynecologic service at Johns Hopkins Hospital, states that 167, or 4.1 per cent, out of a total of 4,071 patients entered from Jan. 1, 1940, to Jan. 1, 1942, were 60 years and over. Included here were 112 operations of practically all types, with the following results: well, 41; improved, 61; unimproved, 7; died, 3. The deaths were ascribed to coronary occlusion and pyelonephritis, and one was moribund with carcinoma of the bladder. Dr. TeLinde prefers pentothal sodium as an anesthetic in this age group.

Dr. Robert T. Mussey, of the Mayo Clinic, states that during a similar period of two years (1939 to 1941), among 27,140 patients admitted, gynecologic patients over 60 years of age numbered 2,430, including 390 breast cases. Operations were done on 585, with 3 deaths; including one each from pulmonary embolism, glomerulonephritis with uremia, and pneumonia. Four hundred thirteen patients were operated upon for rectocele, cystocele, and prolapse, with over 95 per cent either completely cured or improved. For malignant lesions of the breast, among 390 cases, a five-year survival rate of 75 per cent was noted for patients without axillary metastases and 30 per cent with metastases. The five-year survival rate for malignancies of the pelvic organs was 55 per cent. General anesthesia was usually employed, with spinal in a fair proportion of suitable cases.

Dr. Alice Maxwell, of the University of California Hospital in San Francisco, states that among 680 gynecologic admissions during 1939, 69 patients were over 60, many of these over 70. There were no operative deaths. She was impressed by the absence of postoperative complications, no pneumonias or vascular accidents, although many of the patients had a hypertension and two were diabetics.

Dr. William E. Studdiford, reporting from Bellevue, one of the largest New York City municipal hospitals, with an extensive charity service, stated that among 7,971 gynecologic patients in a recent year, 154 were over 60 years of age. Sixty-three operations were performed, of which 28 were of a major character. A total of 19 deaths occurred in the entire series of cases, of which 10 are claimed to be nonoperative.

Dr. W. C. Danforth had 63 operative cases in patients between 60 and 75 years of age, including breast cancers. With a few exceptions

these were major cases and there were no operative deaths. The anesthesia used was ethylene, with one exception. Dr. Danforth feels that if the patient is in good general health, is properly prepared, handled expeditiously and nontraumatically, the risk of surgery is little, if any, greater than in younger women.

I am convinced that a wider inquiry would have elicited reports of equally favorable results. Where operative interference is indicated in the group of older women, there need be less hesitancy in attacking gynecologic problems because of the better understanding of the underlying factors and the developments in pre- and postoperative care and improved anesthetic procedures.

#### SUMMARY AND CONCLUSIONS

You may well ask, What has been the purpose of this presentation? What has been demonstrated and what can we, as physicians, do about a problem which demands our attention as it does that of other interested and affiliated groups? For there are definite medical implications associated with advanced age, which we cannot disregard. If, owing to the progress developed in various fields of endeavor, men and women, broadly speaking, have grown older, what can be done to make this period one of comfort rather than infirmity and debility? As doctors we must be prepared to develop a new field of activity based on more adequate information about the processes of ageing and their amelioration where this is possible. In this connection it is essential to acquire a knowledge of the criteria of physiologic age and not assume, as in the past, that functional and anatomic depreciation parallels chronologic time. For example, in women, as I have stated, the hormonal changes in the climacteric have received special and rather one-sided attention, while the role of vascular changes, the nutritional problems, the psychologic adaptation to advancing years and other features, have been given less thought and consideration.

It may become necessary, in order to appreciate "old age," to revise our method of thinking, perhaps to revise some of our methods of education in medicine. Our students are largely taught by examples of abnormalities without sufficient knowledge of the normal. Their minds are being burdened by the attempt to absorb factual information, often dubious and ill documented, which has developed as the result of the so-called progress in medicine but which, because of its enormous proportions, cannot be digested adequately. And this admission may well be applied to our thesis, namely, the care of our ageing population, for perhaps, as physicians, we have concentrated on the abnormal and neglected the normal status. Unless the latter is definitely and completely understood, we can make no progress in our knowledge of what happens when it goes wrong. We were prone to accept a definite life span and have counted it by years. Now we are finding that perhaps this is false, that the functioning of the human organism depends not alone on mere ageing processes but on the influences of environment, of wear and tear, of proper food and its assimilation, of physical care and sensible living. In other words, prevention, the earlier recognition of destructive agencies, and a wider knowledge of their causative effects are of equal importance with the sociologic developments which have assumed the chief note in the care of old people. I would regard limitation to the latter as a defeatist measure, surely not commensurate



with an advanced and modern method of thought. I would repeat that the almshouse and the home for the aged do not afford the solution. I feel that we must look for the answer elsewhere, by stimulating the thoughts of the medical profession and its allied workers along new lines, rather than merely relegating the increasing numbers of our old people to a domain of despair and uselessness.

Whether we agree or disagree on the solution, there is sufficient evidence which, in part at least, I have endeavored to outline, that the proportion of older people in civilized countries is increasing decade by decade. It would appear essential therefore not only to admit the facts but to enlist and develop our resources for the welfare of the group whether by individual or collective measures. Tissue life may have limitations but these limitations will not be cut short by degeneration and disease to the same degree in the future as they have in the past, for it is unreasonable to believe that the preventive measures which are now operating will become lessened in the will to prolong life and to postpone the advent of death.

NOTE.—In the preparation of this paper I desire to acknowledge my indebtedness to the data and writings of Drs. L. I. Dublin and A. Lotka, of the Metropolitan Life Insurance Company, to Dr. E. V. Crowdry and the contributors to his outstanding compilation entitled *Problems of Ageing*, and to various other authors whose articles have been consulted, including William Cramer, M. W. Thewlis, Müller-Deham, and C. C. Little.

23 EAST 93RD STREET

#### DISCUSSION

DR. FREDERICK J. TAUSSIG, ST. LOUIS, MO.—It is very difficult to discuss a broadly philosophic paper such as Dr. Kosmak's and I can only touch upon two or three points. May I first of all concur with what he had to say regarding the tendency to ascribe too many and too various symptoms to the change of life or menopause. The routine administration of stilbestrol, as done by many practitioners and some of our own specialists, is wrong, because in each case we should try to analyze the patient's psychic and physical condition to see how much influence that has on her general well-being before prescribing endocrine therapy.

There is no doubt that this change in age incidence is going to increase the number of patients who reach the cancer age and that malignancy will become an increasingly important topic for us to consider in our therapy.

If we compare the programs of today with those of the beginning years of our Society we will note a marked difference in the character of papers presented. Then there were many more papers on inflammatory conditions of the adnexa and pelvic injuries than at the present time. I feel therefore that a study of the patients who have reached the cancer age is of great significance. We should, and many of us doubtless do, have patients come to us for a check-up regularly between the ages of 40 and 60. I have at the present time a very large number of women who come to me twice a year, sometimes oftener, for such a physical check-up. And when this is done I do not confine myself to the pelvic examinations but invariably examine the breasts, take blood pressure and urinalysis and, if necessary, refer them to an internist. Now that is all right so far as the private patient is concerned. I wonder whether we are doing our duty to our clinic patients. We have established baby clinics for a check-up on well babies. It seems to me that a similar check-up clinic should be established for examinations of women in the menopause age. If we could establish as part of our *dispensary* service such a clinic to which women between the ages of 40 and 60, without any symptoms, could



come to determine if there are cervical injuries, erosions, etc., we would detect cancer much earlier and greatly benefit our patients.

In conclusion, one word as to the question of prolonging life: Where are we going? Where is this increase in age taking us? Are we adding years to a useful life, or are we merely prolonging existence? I feel that women who have reached 70 to 80 years of age should be trained in some form of occupational therapy, and should have something that will keep their minds and fingers active. If not, they will degenerate mentally, become a burden to the family, and will cease to get any joy out of life. Mere prolongation of existence is not enough. We must strive in every way to keep up the mental activity as well as the physical well-being of these women.

DR. CURTIS F. BURNAM, BALTIMORE, MD.—The question of when old age begins is a very interesting one. We know that the time of the menopause varies enormously among individuals, starting in the thirties and sometimes going far up into the fifties. Old age, for instance, as far as the ears are concerned, apparently begins at about ten years of age. I am informed that audiometer tests on a large number of children and older people show that acute hearing of high tones and range of tones is greatest at about 9 or 10 years of age, and if tests are made 10 years later nobody can hear noises that one could hear at 9, and that diminution in acuity goes straight on through to the end of life. I suppose the same thing is true of many other functions of organs in the body. However, I might say that the ears are still very useful to people in the ordinary work of life for a great many years. A great many octogenarians still have ears that are satisfactory for ordinary use.

DR. KOSMAK (closing).—I have nothing further to say except to express my appreciation of Dr. Taussig's remark that this was a philosophic paper. I would not have dared label it as such myself. I will say that my interest in this subject led to a great deal of reading and I must apologize for having been unable to do more than just sketch the outlines of this enormous field which is now beginning to interest the medical world.

As Dr. Taussig has said, it would be a most desirable thing if we could imitate "well baby clinics" for women of middle age in an effort to detect not only the possible malignancies but also the beginning of other degenerative diseases. I think the subject is one into which even a gynecological society might well expand its labors.

*(The remaining papers presented at this meeting will be included in the December issue.)*

# Department of Reviews and Abstracts

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## Selected Abstracts

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### Endocrinology

**Smith, George Van S.: The Use of Female Sex Hormones in Disorders of Women,**  
New England J. Med. 225: 719, 1941.

A brief discussion of the efficacy of various female sex hormones in the treatment of amenorrhea, dysmenorrhea, premenstrual distress, uterine bleeding, habitual abortion, sterility, senile vaginitis, vulval itching and cystic disease of the mammary glands concludes with the following statement:

"The practical use of female sex hormones in disorders of women is indeed still limited. Clinical trials are vastly easier than fundamental investigation, but until more basic knowledge is acquired, voluminous contradictory and poorly controlled results will continue to appear and bewilder even those who are supposed to have more than average familiarity with the field. Many physicians believe that they are behind the times in the matter of hormone treatment and that others can accomplish more than they can. From my own experience, in practice and laboratory and from a fairly intimate acquaintance with the literature, I can assure them that they really are not behind the times, for just as soon as treatment is found to be clearly and consistently effective, it rapidly comes into universal use. Only estrogen, alone, in the treatment of the menopause has reached that goal."

HUGO EHRENFEST

**Abarbanel, A. R., and Klein, Milton D.: Clinical Experiences With Stilbestrol,**  
New York State J. Med. 41: 383, 1941.

It was found that the synthetic estrogen stilbestrol in dosages up to 500 mg. does not affect established lactation in the nursing human being. If given in doses up to 1,000 mg. (1 Gm.) in divided doses beginning soon after parturition, it will not prevent onset of lactation in the nursing human being, although the appearance of the average normal amount of milk secretion will be delayed until two or six days after the last dose of stilbestrol, provided the baby continues to nurse.

In doses of 25 to 40 mg., it prevented painful engorgement of the breasts in 87.3 per cent of 55 nonnursing mothers. A delayed transitory heaviness or filling of the breasts, usually painless, was noted in 20 of these cases anywhere from the fifth to eleventh post-partum day. In dosages of 100 to 200 mg., it acted as an excellent "priming" agent for the uterus in 80 per cent of the cases where one or more previous medical inductions of labor, including pituitrin, had been unsuccessful. Used alone, without oxytocics, stilbestrol did not precipitate labor.

The pregnant and puerperal patient is remarkably tolerant of stilbestrol in doses from 250 mg. a day to 1,500 mg. a week. No toxic effects were noted even in patients with eclampsia or fulminating toxemia and evident renal and liver damage. In the management of the patient suffering from a menopausal syndrome, the drug, where indicated, is an effective adjuvant in controlling the vasomotor phenomena.

Beginning with 0.1 mg. once or twice a day, the dosage is gradually increased if necessary. With discriminate selection of cases and judicious use of dosage schedule, uniformly gratifying results were secured. The use of bile salts or acids tended to prevent or allay untoward gastrointestinal complaints.

Use of pellets of crystalline stilbestrol injected under the skin of the thigh appears to offer great promise of being an ideal form of therapy in the menopausal patient, provided the proper indications for this type of therapy are carefully observed. In ointment form in a concentration of 10 to 20 mg. per ounce, applied locally in patients with simple senile vaginitis associated with pruritus vulvae, it yields uniformly good results.

In the dose of 0.1 mg. per os or in the form of vaginal suppositories it proved efficacious in the treatment of gonorrheal vulvovaginitis in children.

J. P. GREENHILL

**Cope, C. L.: Excretion of Pregnanediol and Corpus Luteum, Clin. Sc. 4: 217, 1940.**

Cope presents clinical material which confirms the principal claims of Venning and Browne that pregnanediol is excreted in the urine only during corpus luteum activity. Excision of the corpus luteum during early pregnancy results in a rapid fall to zero of the pregnanediol excretion, which normally continues in increasing amounts to full term. Pregnanediol is excreted during the luteal phase of the menstrual cycle, falls to zero before bleeding commences and is absent from the urine during the first, or pre-ovulatory, half of the cycle. In contrast to this, no such excretion of pregnanediol occurred over a period of several weeks in two women with secondary amenorrhea in whom it was unlikely that ovulation was occurring. No pregnanediol was excreted during three excessive uterine bleedings of a woman with a diagnosis of nonovulatory bleeding. This provides additional evidence of the close association between corpus luteum activity and pregnanediol excretion and is compatible with the main thesis of Venning and Browne. However, activity of a corpus luteum in nonpregnant women is usually associated with a secretory type of endometrium.

The fact that the corpus luteum of pregnancy may be removed at the second or even the first month without abortion has led to the assumption that under these conditions the chorionic villi take over the hormone-producing function of the corpus luteum. Since this seems probable, Cope feels that adoption of a similar endocrine function by the normal premenstrual secretory endometrium is not an impossibility. Injection of progesterone in women not excreting any pregnanediol caused a small but definite amount of the substance to appear in the urine. In view of this, it is not justifiable to assume that the magnitude of pregnanediol excretion necessarily gives any quantitative indication of the rate of progesterone production by the corpus luteum. The state of the endometrium might prove an important factor in determining the percentage yield of pregnanediol from a given quantity of progesterone. However, pregnanediol excretion curves may reflect the state of the endometrium more closely than the activity of the corpus luteum. Until contrary evidence is available, one must assume that the observed pregnanediol excretion represents only a small proportion of the total endogenous progesterone production. Therefore it must be determined whether pregnanediol is the most important excretory product of endogenous progesterone. Available evidence does not reveal appreciable quantities of any substance in the urine other than pregnanediol glucuronide and allopregnanediol, probably also present as a glucuronide, which might be considered a breakdown product of progesterone metabolism.

Cope concludes that pregnanediol excretion is a qualitative indication of corpus luteum activity in the nonpregnant woman and that it probably indicates progesterone

production in pregnant and nonpregnant women. He does not believe that the pregnanediol excretion rate provides a reliable estimate of the intensity of corpus luteum metabolism. The great discrepancy between the relatively large amounts of pregnanediol recovered after progesterone injection by Venning and Browne and the failure to recover any by Hamblen, Ashley and Baptist and by Stover and Pratt together with Cope's intermediate recoveries suggests to him that other factors, undefined, are concerned in determining the pregnanediol excretion from a given quantity of progesterone. If this is probable after injection of progesterone, it may be equally probable for endogenous progesterone. He believes that hormone influences other than renal or hepatic and the metabolic state of the uterus and endometrium will be proved important in progesterone metabolism and pregnanediol excretion. The assumption that pregnanediol excretion reflects quantitative variations in corpus luteum activity is unsupported by direct evidence.

J. P. GREENHILL

**Quintela, F.: Factors Affecting Intersexuality, Rev. méd. munic. Rio de Janeiro 1: 783, 1941.**

The author gives an extended and complete discussion of chromosomal factors affecting sexuality and cites an interesting case of intersexuality in a woman of male skeletal structure with a greatly enlarged clitoris which resembled the male organ in many respects, including urinary meatus. Quintela concludes that in spite of extensive overlapping in many individual cases three general morphologic and physiologic groups may be defined: First, a very early inversion with arrest of gonad cortex growth and overgrowth of medullary tissue. This is associated with growth of Wolffian ducts and male type internal genitals. Second, a midway inversion in which there is little cortical gonad differentiation of male elements (ovotestis). Here growth of uterus and tubes is at a standstill; Wolffian canal is moderately well developed. The third and ultimate stage of this process shows the ovary well developed but with little cortical potentiality. Microscopically an involutional type of structure is seen. The uterus is small, tubes infantile, Wolffian remnants more or less well developed.

Sexuality, says the author, is first presaged by chromosomal factors, second by embryonic "cortexin" and "medullarin" of the gonads. Finally the fully developed gonad elaborates the true gonadal hormones of adult life.

R. J. WEISSMAN

**Lipschutz, Alexander, and Vargas, Luis: Prevention of Experimental Fibroids by a Cortical Hormone, Lancet 1: 568, 1941.**

Further studies of the tumorigenic action of estrogenic substances in the guinea pig reveal that the acetic ester of desoxycorticosterone completely prevents the development of uterine fibroids and reduces the production of extra genital fibroids to a minimum. Extreme development of the uterus and uterine bleeding were also inhibited. The amount of desoxycorticosterone necessary to inhibit tumorigenic activity is about three times the amount of estradiol necessary to produce tumors. In this action it is superior to testosterone and progesterone.

CARL P. HUBER

**Kneer M.: Effect of Follicle Hormone on the Function of the Human Uterine Musculature, Arch. f. Gynäk. 170: 483, 1940.**

The investigations showed that the follicle hormone stimulates growth of the muscle fibers of the human uterus and also produces an increase and loosening of the

intermuscular connective tissue. Therefore, the uterus increases in size and the cavity enlarges. During the menstrual cycle there is no effect on the uterus as regards contractions even when large doses are given. Pituitary extract produces an increased pressure within the uterus only after estrogen has been secreted in the body, namely, at the time of menstruation. In some cases there is a reverse reaction; that is, pituitary extract produces a fall in intrauterine pressure.

The pregnant uterus does not react to administration of estrogen or of follicle hormone in the form of pregnancy serum; hence pregnancy cannot be disturbed in this way. Uterine contractions begin only when the increase in length of the muscle fibers and the increase in connective tissue ceases. The posterior pituitary hormone then induces uterine contractions to produce increased intrauterine pressure.

The growth impulse of the uterus during pregnancy comes from the follicle hormone which is formed in the placenta. The increased output of estrogen toward the end of pregnancy is indicative of the removal of this hormone which now becomes superfluous and must be removed in order to permit the uterus to react to the posterior pituitary hormone so that labor may begin.

During pregnancy the uterus is prevented from reacting by the inhibiting action of the corpus luteum hormone and the gonadotropic chorionic hormone.

J. P. GREENHILL

**Hoffmann, Fr., and Treite, P.: Influence of Follicle Hormone on Bladder Capacity, Zentralbl. f. Gynäk. 65: 783, 1941.**

Hoffmann administered 5 to 10 mg. of estradiol to a group of women in premenopausal and climacteric ages who were suffering from frequency of urination and incontinence with atonic bladders. The average bladder capacity was determined prior to medication and three, five, and twelve days after medication. Subjective relief was experienced in varying degree in all cases and a maximum diminution in bladder capacity was noted three days after medication, slowly increasing to the twelfth day. Reductions for the series ranged from 27 to 45 per cent, average 35.

R. J. WEISSMAN

**Guirdham, A.: Sex Hormones and Blood Pressure, Bristol Med.-Chir. J. 58: 19, 1941.**

The author quotes Simpson and Schaefer who indicate that estrogens favorably affect menopausal hypertension and that testosterone, by a stabilizing effect on sympathetic-parasympathetic balance, can either raise or lower blood pressure in the absence of hyperpiesis due to organic disease. Two interesting cases are cited. (1) A 78-year-old woman with a pressure of 220/120, gross arterial degeneration and enlarged left ventricle was given 0.14 mg. of estradiol daily by inunction, resulting in reduction of pressure to 150/70 in two weeks with improvement in mental condition (depression). (2) A 53-year-old patient with melancholia, arteriosclerosis, myocarditis, poor peripheral circulation, and a pressure of 164/84 was given 0.28 mg. of estradiol ointment daily, increased in 14 days to 0.56 mg. In nineteen days marked mental improvement and reduction of pressure to 105/65 occurred. The dose was reduced to 0.56 mg. every other day for one month, with great subjective mental and physical improvement, and pressure was 96/60. The medication was omitted for one month and pressure rose to 108/60 in thirty days. Now inunction with testosterone, 2 mg. daily, raised pressure to 130/70. Patient appeared brighter and more dynamic. The dose was raised to 4 mg. and in four days the pressure was 148/70.

R. J. WEISSMAN



**Hoepfner Dutra, L.: Opothepy and Hormone Therapy in Menopause, An. brasil. de Ginec. 9: 395, 1940.**

In a case of surgical menopause the author observed vaginal changes in biopsy and smear as affected by oral administration of whole ovary in large doses, folliculin and stilbestrol. Although some changes were noted following whole ovary medication, folliculin and stilbestrol produced more pronounced and longer lasting effects.

R. J. WEISSMAN

**Ottoway, John P.: The Correlation of Vaginal Smear Changes in the Estrogenic Treatment of Menopausal Symptoms and Senile Vaginitis, Harper Hosp. Bull. 1: 29, 1941.**

Twenty-eight patients with menopausal symptoms were studied by the vaginal smear method. The initial vaginal smears before treatment indicated an advanced or moderate estrogenic deficiency in 10 patients. Eleven showed slight deficiency and seven presented normal Grade 4 smears. Treatment consisted of weekly or semi-weekly injections of estradiol varying from 1,000 to 10,000 rat units per injection. Two patients were slightly relieved, 18 partially relieved, and 8 entirely relieved. Objective improvement as recorded by the vaginal smears was seen in only 14 of the 28 patients. Only 6 progressed from a deficient type to a normal Group 4.

Ten patients were treated for senile vaginitis. Initial smears revealed moderate or advanced estrogenic deficiency in 7 cases, and the remaining 3 showed slight but definite deficiency. Treatment consisted of the daily local application of estradiol in vaginal suppository form, the dosage varying from 480 to 4,800 rat units per suppository. Progressive improvement in the vaginal smear was obtained in 6 patients. The remaining 4 cases showed little change in the smears, and there was little or no improvement in the vaginitis.

WILLIAM BERMAN

**Hoskins, Roy G.: The Current Status of Female Sex Hormones, New England J. Med. 225: 722, 1941.**

Quite recently, an eminent gynecologist, who had himself made important contributions to this problem stated in effect that, except for a certain amount of amelioration of the discomforts of the menopause, gynecic endocrinology had contributed practically nothing to the welfare of women. "The condemnation was no doubt too sweeping, but it serves to raise the question why the discoveries of the investigators have failed to yield more substantial clinical returns." It is the aim of the writer to consider basic advances in information concerning sexual physiology of women and to suggest certain possibilities for the extension of clinical research, with the idea of making the physiologic discoveries more fruitful.

In consequence of a double reciprocating arrangement, on every day of the month, four important hormones (luteinizing, progesterin, follicle stimulating, and estrogen) are normally present in different absolute amounts, as well as in different proportions of one to another. Only by this precise and constantly shifting system of checks and balances is the normal menstrual cycle maintained. Any serious dislocation of this fourfold balance spells menstrual disorder. Without taking these fundamental facts fully into account actual restoration to normality cannot be obtained.

Pituitary gonadotropins as at present available are probably not worth using. It has become possible to separate the follicle-stimulating from the luteinizing pituitary hormone, but the yield is small, and "these two hormones are consequently too expensive for the use of anyone but investigators and millionaires." The mare serum gonadotropin was formerly believed to give pure follicle stimulation, but as recently shown it also influences corpus luteum formation. Successful therapeutic

control of cyclic ovarian function in large measures still awaits commercial production of the two pituitary hormones in separate form. But even then the practical difficulty will remain to duplicate the continuously varying amounts of gonadotropins flowing into the blood stream. Efforts could be made to control the gonadotropin output of the pituitary by administration of estrogen and progestin but also the natural ebb and flow would still remain as essential requirement. These complexities are Nature's doings and must be faced.

It is true that any of the four hormones can be given arbitrarily in any dose desired, and may by good luck restore normality. The best that can be hoped for by any system of constant dosage is the substitution of one abnormal condition for another. It may or may not be better than the abnormality it supersedes. It sometimes is better and the patient secures relief.

Only in the menopause current therapeutic practice comports adequately with physiologic principles.

Another striking fact, which the practical therapist conventionally ignores, is that women produce nearly as much male sex hormone as men. It is possible that this paradoxical arrangement is meaningful and that the therapist may have to reckon with it before his results can become satisfactory to him or his patient. Another theoretical, if not practical, complication of gynecic endocrinology is that the adrenal cortex is able to produce sex hormones, both estrogens and androgens. What part the adrenal glands may play in cyclic sex activities of normal women is still completely unknown.

An additional hormone with considerable influence on reproductive processes is prolactin. It is unknown whether aberrations of prolactin might possibly be of significance for menstrual disorders.

There is not now and probably never will be any effective easy way to practice gynecology by using endocrine therapy.

HUGO EHRENFEST

**Stemmer, W.: The Vegetative Effects of Semen on the Female Organism, Zentralbl. f. Gynäk. 64: 1528, 1940.**

Stemmer has made an almost encyclopedic study of the influences attributed to seminal absorption from writers like Hippocrates, who observed that women having regular sexual intercourse were healthier, to date. The author concludes that a good deal of absorption takes place from the seminal pool and that substances of biologic nature similar to male hormone are deposited in the semen and have various effects upon the woman. A sort of postcoital endometritis has been noted by some workers quoted by Stemmer and he believes that this leucocytic response to the presence of semen on the endometrium is one of the prime factors in the growth of the hypoplastic uterus which is often noted in married women. Sexual intercourse results in mobilization of thyroxin in the individual; the increased metabolism resulting allows greater absorption of seminal components. The author notes in contrast the altered clinical and serologic findings in women practicing masturbation, coitus interruptus, or using chemical means of contraception. As added evidence of the influence of seminal factors, the author cites the difference in color of fertilized and unfertilized eggs, in some species of Aves, and the additional fact that some species of animals even during pregnancy have a period of receptivity to the male.

R. J. WEISSMAN

**Bompard, E.: Treatment of Uterine Functional Hemorrhages by the Male Hormone, Rev. franc. de gynéc. et d'obst. 36: 77, 1941.**

The author maintains that functional uterine hemorrhages can be cured or relieved in nearly all cases by injections of testosterone. This therapy has changed the man-

agement of functional uterine bleeding by considerably reducing the incidence of curettement and radiation therapy. The acetate and propionate have identical effects. In most cases of premenstrual bleeding from 50 to 200 mg. usually suffice. However, in serious cases of bleeding a cure cannot be obtained unless from 300 to 800 mg. of testosterone are given during a period of three to four weeks. Following this it is necessary to give from 50 to 200 mg. during each of the next two or three months. The usual results of this therapy are amenorrhea for a few months and atrophy of the endometrium. These results are not objectionable because the effects of testosterone are temporary.

J. P. GREENHILL

**Ehrhardt, K.: Clinical Experiments on Pregnancy Maintaining Effect of Corpus Luteum Hormone After Loss of Corpus Luteum of Pregnancy, Zentralbl. f. Gynäk. 65: 541, 1941.**

The author removed the corpus luteum of pregnancy during abdominal sterilization of women whose pregnancy was to be interrupted for medical or eugenic reasons and administered varying doses of corpus luteum hormone, to determine optimal dosage for maintenance of pregnancy. In the experiments with mice fetal death occurred after large doses of corpus luteum hormone. Somewhat smaller doses resulted in retention, maceration, and resorption of uterine contents. In the same animal, however, live, dead, macerated, and resorbing fetuses could be seen. Doses of 5 Corner units or more resulted in death of all fetuses; 2.5 to 5 units resulted in partly live and partly dead litters but part of the living offspring died in the neonatal period, possibly due to poor suckling as well as previous intrauterine injury. Similar results were obtained with guinea pigs.

The corpus luteum of pregnancy is said to be most active during the first trimester, then beginning retrogression. Ehrhardt and others determined the corpus luteum hormone content of the young placenta was negligible, activity beginning in the fourth to fifth month and at its best during the sixth or eighth month. The mature or term placenta has relatively low and inconstant amounts of corpus luteum hormone. The author feels that habitual abortion is prone to occur during the third month while the corpus luteum of pregnancy is losing its function and the placenta is beginning to take over corpus luteum hormone production. Since no damage has resulted to pregnancy in clinical work with doses of up to 1400 mg. of corpus luteum hormone, the possibility of overdosage appears small. Some workers have felt that administration of corpus luteum hormone in threatened abortion increased bleeding and contractility of the uterus, but where the products expelled have been examined with care pathologic ova have generally been found. The author cites several cases of removal of corpus luteum of pregnancy: This was done in a 35-year-old patient who was two and one-half months pregnant. Fourteen hundred mg. of corpus luteum hormone was administered over the first 16 postoperative days. Two attempts at medical induction and a fall downstairs did not affect the fetus. Vaginal induction thirty-seven days after operation resulted in expulsion of a live 16 cm. fetus. The operation was performed on a 40-year-old woman two and one-fourth months pregnant. She received 400 mg. corpus luteum hormone over the first 11 postoperative days followed by two futile attempts at medical induction. Vaginal induction twenty-two days postoperatively resulted in expulsion of a live 12 cm. fetus. A 33-year-old woman two and one-half months pregnant received 260 mg. of corpus luteum hormone after removal of the corpus luteum. Two unsuccessful medical inductions were followed by expulsion of a live 15 cm. fetus after vaginal induction on the twenty-second postoperative day. The author also cites a case of habitual abortion in which pregnancy was successfully carried to term after corpus luteum hormone had been administered in the interval between impregnation and implantation of the ovum. The author concludes that corpus luteum hormone should be given in large doses where

its use is indicated and if the corpus luteum of pregnancy should be removed at operation and maintenance of pregnancy is desired, administration of the hormone should be begun simultaneously with the operation if not sooner.

R. J. WEISSMAN

**Hamblen, E. C., and Pullen, R. L.: The Endocrine Therapy of Ovarian Failure, Virginia Med. Monthly 68: 375, 1941.**

Rational therapy of ovarian failure is dependent upon the establishment of a correct diagnosis, the degree and the nature of the ovarian impairment, and the segregation of the etiologic factors underlying the ovarian failure. There are three established symptoms and signs of marked ovarian failure: one, failure of occurrence or cessation of menstruation; two, nonoccurrence of sexual maturation, or regressional changes in the sex organs; three, impaired fertility or sterility. Ovarian failure may be either of the corpus luteum (failure of ovulation) or estrogenic variety. The causes of ovarian failure fall into two general groups: one, extraendocrine, and two, endocrine causes. In the former are included acute and chronic debilitating diseases, vitamin deficiencies, emotional and psychic disturbances, etc. The alterations in ovarian function are likely attributable to indirect effects on the pituitary-ovarian axis mediated via the pituitary gland. The endocrine causes of ovarian failure include intrinsic ovarian failure, hypofunction of the pituitary, diseases of the adrenal and thyroid glands, endometriopathic factors, and gametopathic factors.

There are three general indications for the endocrine therapy of ovarian failure per se: (1) completion of sexual development in adolescent failure; (2) therapy of undesired sterility in adult failure; and (3) treatment of irregularities of uterine bleeding. In adolescent failure, gonadotropic hormone in the form of equine gonadotropin in doses of 400 to 800 I.U. every two days for a period of six weeks, followed by a second series after a rest period of six weeks, is indicated. If no response is obtained it may be assumed that no pituitary deficiency exists. Substitutional ovarian therapy is then indicated. The authors advise the use of 1 to 2.5 mg. of estradiol benzoate or estradiol dipropionate every two or three days until there is genital response. In adult ovarian failure before the menopause, the authors advise the cyclic employment of estrogen-progesterone therapy, using 0.3 mg. of estradiol benzoate every two days for a period of ten days followed by 0.3 mg. of estradiol benzoate and 5.0 mg. of progesterone every other day for ten days. If no response is obtained, as shown by endometrial scrapings, after two such series of cases estradiol benzoate and progesterone are given simultaneously during the latter half of the menstrual cycle. The authors do not give the results of their treatment.

EUGENE S. AUER

**Sievers, K., and Schenz, H.: Experiments to Determine Follicle Hormone Effect on Uterine Activity, Zentralbl. f. Gynäk. 64: 1522, 1940.**

The authors wished to determine whether the increased follicle hormone in circulation at the end of pregnancy had any influence upon uterine tonus or activity. Castrated dogs, in their experiments, showed no response to the administration of pituitrin when follicle hormone had been intravenously administered previously. The same animals, however, showed a good response to pituitrin when estradiol had been given at least one week previously. They conclude that a direct stimulating or tonic effect of follicle hormone was not demonstrated.

R. J. WEISSMAN

**Bennett, M. J., and Russell, P. B.: Vaginal Smears Correlated to Ovarian Function (Four and One-Half Months' Fetus Through Puberty),** *South. Surgeon* 10: 79, 1941.

The examination of daily vaginal smears is a valuable aid in the diagnosis of ovarian dysfunctions when correlated with biologic assays, blood chemistry determinations, and other studies. Indications for therapy are based upon the information obtained.

Cyclic changes occur in the vaginal mucosa which indicate either follicular or luteal stimulation, and they represent the anaphase and cataphase of ovarian activity, respectively. Each is characterized in the smear by a typical cytologic and bacteriologic appearance. Vaginal smears of a woman at the eighteenth week of pregnancy revealed evidence of luteal domination, while vaginal smears of her fetus at this period of gestation indicated follicular stimulation. This is interpreted as signifying that function of the fetal ovaries has commenced, and that they are independent of maternal influence. At twenty-eight weeks' gestation, both the maternal and fetal vaginal smears show predominance of follicular stimulation, while on the day of full term the same reaction is present. Vaginal smear evidence of the follicular phase persists in the full-term infant until approximately its ninety-fourth day of life. Hormone stimulation of the maternal milk upon the nursing infant's ovaries is negligible.

The authors make the statement that: "It seems an easy matter to predict the cycle of the mature female and diagnose abnormal ovarian conditions by studying the vaginal smears of the young female previous to the onset of the menses or puberty."

ARNOLD GOLDBERGER

**Pardini, Icilio: The Hormonal Content of Parovarian Cystic Fluid Removed During Pregnancy,** *La Ginecologia* 19: (Series 2) 187, 1941.

The author reports his findings from four Friedman tests performed with cystic fluid aspirated from parovarian cysts. The tumors, from which the cystic fluid was obtained, were removed by laparotomies upon four patients. All of these patients were pregnant at the time of their operations. Two women were in their second month of pregnancy, one case was six months pregnant, while the last case was at term at the time of her surgery.

All four of the Friedman tests were reported negative. The uteri and ovaries of each of the test animals were examined by laparotomy prior to their use as test animals. A total of 24 to 32 c.c. of cystic fluid from the parovarian tumors were used in each test animal. Each animal received a 6 to 8 c.c. intravenous injection of the cystic fluid in its ear veins on four occasions.

The author concludes with the theory that the pathologic changes in the capsule of the ovarian cyst precluded interexchange of tissue fluids between that within the tumor and that in the body. Inasmuch as the fluid in the cystic tumors was antecedent to pregnancy, it followed that the Friedman pregnancy test done with the tumor liquid would be negative, as it proved to be.

CLAIR E. FOLSOME



## Correspondence

### Vitamin C Deficiency as a Possible Factor in the Pathogenesis of Erythroblastosis Fetalis

*To the Editor:*

The increasing attention which is being given to iso-immunization during pregnancy by the Rh factor with its extreme danger of transfusion accident in the mother (Burnham, L.: *AM. J. OBST. & GYNEC.* 42: 389, 1941) and high mortality rate in the baby (erythroblastosis) necessarily should include a search for any etiologic agent which may permit iso-immunization. I am prompted therefore to submit for consideration a possible explanation for the transfer of blood from the fetal circulation to the maternal circulation. This transfer has been assumed to occur, thereby leading to iso-immunization of the mother and resulting in the various manifestations of erythroblastosis in the baby in the following manner:

Since the Rh factor occurs in the red blood cells and is probably limited to them, it has been assumed by Levine (Levine, P., Burnham, L., Katzin, E. M., and Vogel, P.: *AM. J. OBST. & GYNEC.* 42: 925, 1941) that red blood cells of the fetus must pass through the capillaries and epithelium of the chorionic villi into the intervillous spaces and thus into the mother's blood stream in sufficient numbers to induce immunization. Subsequently intervillous hemorrhages of fetal blood within the placentas of patients who have delivered erythroblastic babies were described by Javert. (Javert, C. T.: *AM. J. OBST. & GYNEC.* 43: 921, 1942. Also personal communication to the author.) This provides evidence of the escape of fetal blood into the maternal circulation, resulting in immunization of the mother by the Rh factor and the formation of anti-Rh agglutinins in the mother's serum. These agglutinins, in common with other antibodies, are then free to pass through the placental barrier into the fetus where they agglutinate and destroy its blood, thus causing erythroblastosis. In addition, if the mother be transfused with blood containing the Rh factor, these agglutinins are free to agglutinate and destroy the transfused red blood cells causing jaundice and transfusion anuria.

I believe that a vitamin deficiency in the mother must be considered as a possible factor in the passage of fetal blood through the tissues of the chorionic villus. It is well known that vitamin C is not stored in the body, thus necessitating a daily intake and, that a deficiency of vitamin C causes damage to the endothelium of blood vessels. It seems logical to expect that this damaging effect would be more pronounced on the newly forming and formed capillaries of the chorionic villi than on the well-developed capillaries of the adult. Thus a subclinical deficiency of vitamin C in the mother might be sufficient to permit a break in the integrity of the capillaries of the chorion with the escape of fetal blood.

Dalldorf (Dalldorf, G.: *Am. J. Dis. Child.* 46: 794, 1933) has shown a definite relationship between the vitamin C value of the food and the resistance of the capillary and walls. The escape of blood from capillaries with the resultant formation of petechiae occurred more readily when there was a shortage of vitamin C. This was true even when the deficiency was not sufficient for the development of manifest scurvy.

Likewise, Hess (Hess, A. F.: *Scurvy, Past and Present*, Philadelphia, J. B. Lippincott Co.) has pointed out that children exhibiting symptoms of irritability, lack of stamina, and retardation of growth can be cured by increasing the amount of vitamin C in the diet even though the diet has been sufficient to prevent scurvy.

Hence it seems possible that a relative deficiency of vitamin C existing over a shorter or longer period of pregnancy would be sufficient to allow fetal blood to pass through the chorion with iso-immunization resulting. Many pregnant women

have nausea and vomiting during the early months of pregnancy and not infrequently these disturbances of the gastrointestinal tract persist throughout long periods of pregnancy, thus interfering with the ingestion of fruits and fruit juices. In addition some patients have food habits and tastes which make adequate vitamin C intake unlikely, while others state that they cannot eat fruits or fruit juices because of indigestion.

The history of one of the most recent cases of immunization (Case C. M. M.) was investigated from this standpoint. It was so suggestive that this patient may have had a pronounced vitamin C deficiency over a long period of her pregnancy that a few other recent cases were investigated together with two previously reported cases (J. L. and H. H.).

Ten Rh negative mothers of erythroblastic babies have been carefully questioned as to their diet during pregnancy. Nine of the ten have histories very suggestive of vitamin C deficiency in the diet during at least some appreciable part of their pregnancies and none of these nine took any capsules containing vitamin C at any time. The tenth patient took a large number of multivitamin capsules as well as a diet containing plenty of vitamin C and yet delivered an erythroblastic baby. This apparent exception might still be explained on a failure of assimilation of vitamin C from the intestinal tract even though the intake was ample.

An eleventh patient should be mentioned because she took a large amount of vitamin C throughout her pregnancy and delivered an apparently normal baby when an erythroblastic baby was to have been expected.

This last patient (H. H.), who was the first in whom the anti-Rh agglutinins were ever identified, was delivered two years ago of an apparently normal baby in spite of the demonstrable presence of the anti-Rh agglutinins in her serum. These agglutinins are proof that the process of immunization has taken place, and up to this time it has been a puzzle as to why the baby was apparently not affected. The fact that this patient was instructed to take orange or other fruit juice every day and took Abdol with vitamin C capsules twice daily starting at the seventh week, now offers a possible explanation, i.e., that the immunization occurred during previous pregnancies, three of which ended in early or late spontaneous abortions. It is interesting to note that weak anti-Rh agglutinins are still demonstrable in her serum two years after her last (normal) pregnancy.

These 11 cases, with the one exception, are mentioned as suggestive evidence in support of the hypothesis of vitamin C deficiency in the role of iso-immunization. Vitamin C determinations during all stages of pregnancy and detailed examination of the placentas to corroborate the finding of intervillous hemorrhages are now being carried on in an effort to prove or disprove this hypothesis.

The hypothesis that vitamin C deficiency during pregnancy permits fetal red blood cells to escape into the maternal circulation, thus leading to iso-immunization of the mother by the Rh factor, and resulting in the various manifestations of erythroblastosis in the baby, is submitted for consideration.

The prevention of iso-immunization and erythroblastosis may therefore depend upon daily adequate vitamin C intake by the mother.

It is suggested that all pregnant patients be given adequate vitamin C daily starting as early in pregnancy as possible; and that those patients who have been or may be subject to iso-immunization (erythroblastosis fetalis) be given large amounts of vitamin C every day (by injection if necessary).

The patients who may be subject to immunization include all Rh negative women with Rh positive husbands, especially those who have delivered erythroblastic babies, as well as those untested women who have had an unexplained macerated fetus, stillbirth, neonatal death or late abortion.

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AUGUST 12, 1942

## Announcement

### A Registry of Ovarian Tumors

At its recent annual meeting the American Gynecological Society undertook the sponsorship of an *American Registry of Ovarian Tumors*, and appointed from its Fellows a committee of five gynecologic pathologists to carry on this work.

The need and wisdom of such a project must be obvious to every gynecologist, for no problem of pathology is in greater need of clarification. No entirely satisfactory classification of ovarian tumors exists, largely because of our ignorance of the histogenesis of many of these growths. Even in tumor types which are fairly well defined, such as the papillary growths, prognosis is often difficult, because of the not infrequent lack of parallelism between clinical and histologic malignancy, and mistakes in both diagnosis and prognosis are frequent. Again, tumors are not infrequently encountered concerning the nature of which even expert pathologists cannot be certain. Finally, a whole group of ovarian tumors of rather special histogenesis and histology has been described in recent years, and there are many pathologists who, because of the relative rarity of these tumors, have had no opportunity of familiarizing themselves with their histologic characteristics.

Instead of limiting its study to a registry of rare ovarian tumors, comparable perhaps to that which has been employed so successfully by general pathologists with bone sarcoma, the committee has decided to widen its scope to include ovarian tumors of all varieties. It therefore seeks the cooperation of all gynecologists and pathologists in this ambitious project, and appeals to them for cooperation by seeing to it that properly prepared slides of all ovarian tumors, more particularly those of unusual or doubtful nature, be sent to this central registry for composite study by the members of the committee.

With the slides should be sent an adequate clinical history, including such essential data as the patient's age, menstrual and marital history, gynecologic findings, and the operative procedure carried out, as well as a gross description of the tumor. Where photographs of the latter are available, they would be welcome. If the gross specimen or blocks of tissue are sent, they should be fixed in 10 per cent formalin.

It is obvious that the real value of such a study would be enormously lessened if it did not include also a study of the subsequent course of the patients, particularly in the malignant and doubtful groups of tumors. Such correlated clinical and histologic study must be the chief hope of improving our evaluation and classification of ovarian neoplasms. To facilitate such a follow-up study the name of the attending surgeon should be included in the data.

The Committee has no intention of making this a purely diagnostic service, but all those who send in slides will in due course receive reports of the diagnosis and classification arrived at by the Committee. Since each slide will be studied by every member of the Committee, and perhaps by other pathologists as well, and since this will involve corre-

spondence between men scattered in different sections of the country, it will be understood that such reports of findings cannot be made with great promptness.

Finally, the Committee fully appreciates that many of the ovarian tumors submitted to it will be worthy of report by the referring physicians, and it need scarcely emphasize that neither the Committee as a whole, nor any individual member thereof, will utilize any submitted case for publication without the express permission of the referring physician. It is hoped that, as the work progresses, reports of the Committee's studies will be published from time to time, but those referring cases for study will be given full credit in any such publication.

The Committee feels that it has been given a great opportunity to render a worth-while service and it sincerely hopes that individual clinicians and pathologists in all sections of the country will feel that they too can contribute vitally in this project, by developing the routine of sending slides of interesting ovarian tumors, with the above indicated data, to the committee for study and registry. This material should be mailed to Dr. Emil Novak, Laboratory of Gynecological Pathology, Johns Hopkins Hospital, Baltimore, Md.

EMIL NOVAK, CHAIRMAN  
ROBERT MEYER  
HERBERT F. TRAUT  
GEORGE H. GARDNER  
KARL MARTZLOFF

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## Items

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### American Board of Obstetrics and Gynecology

The next written examination and review of case histories (Part I) for all candidates will be held in various cities of the United States and Canada on Saturday, February 13, 1943, at 2:00 P.M.

Arrangements will be made so far as possible for candidates in military service to take the Part I examination (written paper and submission of case records) at their places of duty, the written examination to be proctored by the Commanding Officer (medical) or some responsible person designated by him. Material for the written examination will be sent to the proctor several weeks in advance of the examination date. Case records may be submitted in advance of the above date, only by candidates in Service, by forwarding these to the office of the Board Secretary by the candidate upon entering military service, or in the event of assignment to foreign duty. All other candidates should present their case records to the examiner at the time and place of taking the written examination.

The Office of the Surgeon-General (U. S. Army) has issued instructions that men in Service, eligible for Board examinations, be encouraged to apply and that they may be ordered to "Detached Duty" for the purpose of taking these examinations whenever possible. The Office of the Surgeon-General of the U. S. Navy presumably takes a similar attitude on this matter.

All candidates will be required to take both the Part I examination, and the Part II examination (oral-clinical and pathology examination). Candidates who successfully complete the Part I examination proceed automatically to the Part II examination to be held later in the year.

The Part II examination for this year will be held at Pittsburgh, Pa., beginning Wednesday, May 19, and closing Tuesday, May 25, 1943.

If a candidate in Service finds it impossible to proceed with the examinations of the Board, deferment without time penalty will be granted under a waiver of our published regulations covering civilian candidates.

Candidates for re-examination in this year's Part I must request such re-examination before December 15, 1942.

For further information and application blanks, address Dr. Paul Titus, Secretary, 1015 Highland Building, Pittsburgh (6), Pennsylvania.

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### Central Association of Obstetricians and Gynecologists

By a decisive vote of the membership, the annual meetings of this Association have been suspended for the duration of the War.

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### American College of Surgeons

The 1942 Clinical Congress of the American College of Surgeons, originally scheduled for October at the Stevens Hotel, Chicago, which was taken over August 1 by the United States Army Air Corps, will be held in Cleveland, with headquarters at the Cleveland Public Auditorium, from November 17 to 20, 1942. The twenty-fifth annual Hospital Standardization Conference sponsored by the College will be held simultaneously.

The program of panel discussions, clinical conferences, scientific sessions, hospital meetings, and medical motion picture exhibitions at headquarters, and operative clinics and demonstrations in the local hospitals and Western Reserve University School of Medicine, has been centered around the many medical and surgical problems arising out of the prosecution of an all-out effort to win the war, emphasizing the needs of the rapidly expanding medical services of the Army and the Navy, and consideration of special problems related to the increasing activities for civilian defense.

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### Books Received

**SEX FULFILLMENT IN MARRIAGE.** By Ernest R. Groves, Professor of Sociology, University of North Carolina, Gladys Hoagland Groves, and Catherine Groves. Introduction by Robert A. Ross, M.D., Associate Professor of Obstetrics and Gynecology, Duke University, School of Medicine. Illustrated (by Robert L. Dickinson, M.D.), 319 pages. Emerson Books, Inc., New York, 1942.

**MARRIED LIFE IN AN AFRICAN TRIBE.** By I. Schapera, Professor of Social Anthropology in the University of Capetown. With an introduction by Bronislaw Malinowski. Illustrated. 364 pages. Sheridan House, New York, 1942.

**GLANDULAR PHYSIOLOGY AND THERAPY.** A Symposium, prepared under the auspices of the Council on Pharmacy and Chemistry of the American Medical Association. American Medical Association, Chicago, 1942.

**BLOOD GROUPING TECHNIC.** By Fritz Schiff, M.D., Late Chief of Department of Bacteriology, Beth Israel Hospital, and William C. Boyd, M.D., Associate Professor of Biochemistry, Boston University School of Medicine, etc. With a Foreword by Karl Landsteiner, Rockefeller Institute for Medical Research. 248 pages. Interscience Publishers, Inc., 215 Fourth Ave., New York, 1942.

**WAR GASES.** Their Identification and Decontamination. By Morris B. Jacobs, Ph.D., formerly Lt. U. S. Chemical Warfare Service Reserve. 180 pages. Interscience Publishers, New York, 1942.